

2 JUL 1990

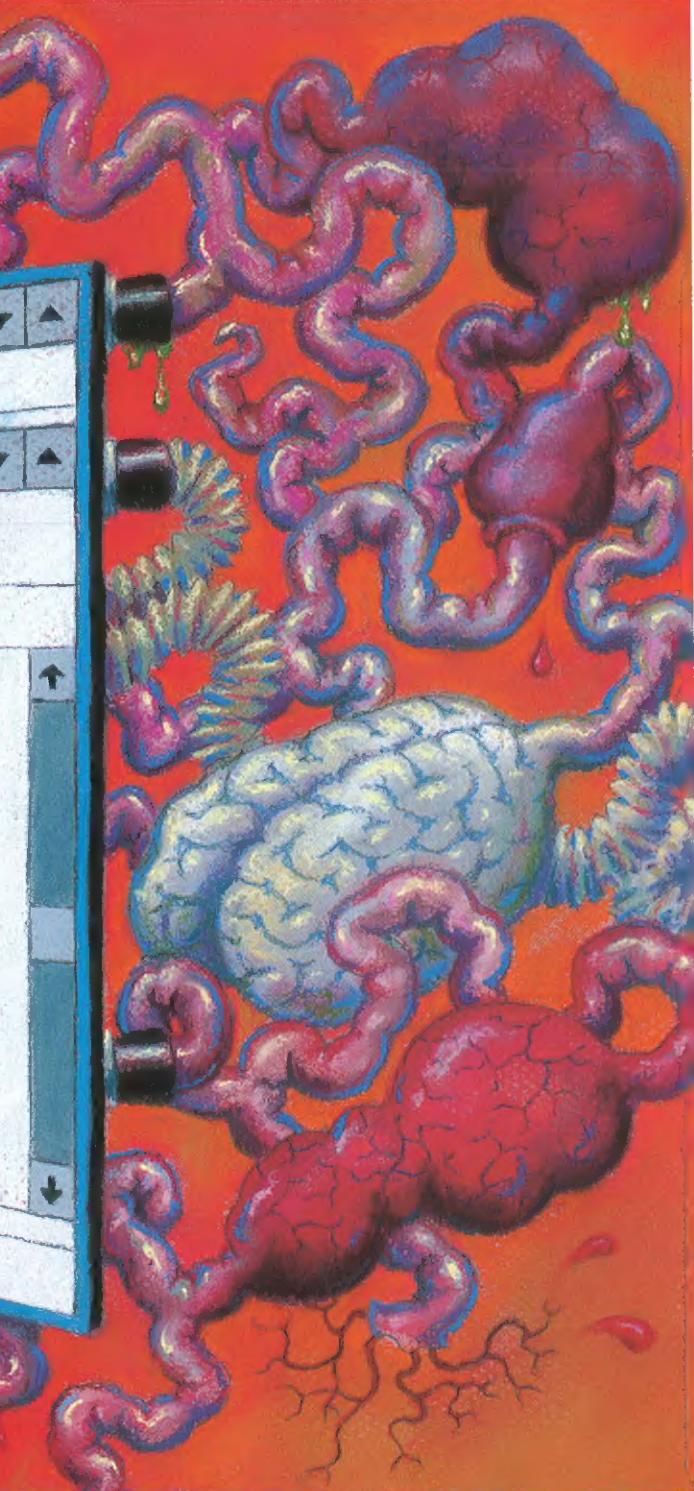
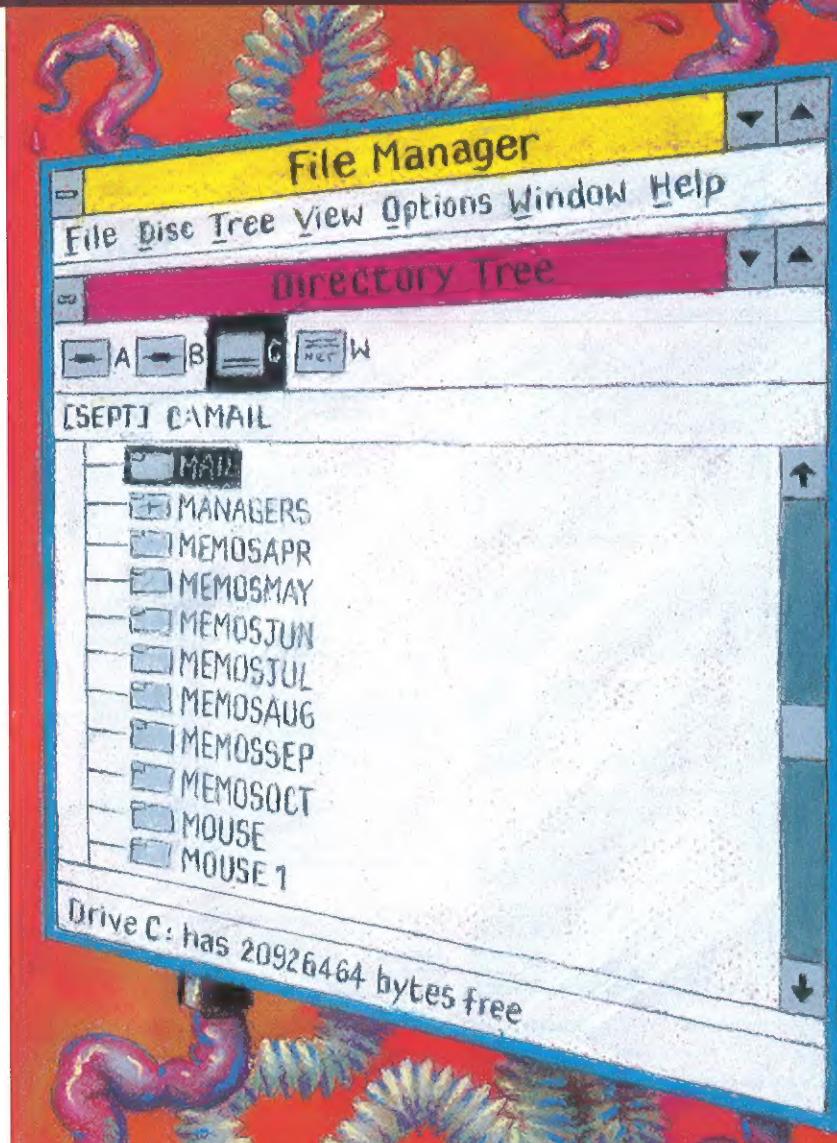
*The Software Developers' Magazine*

# EXE

JULY 1990

VOL 5

ISSUE 2



*Inside Windows 3. We have a programmer's eye view from behind its glitzy façade.*

*Here is Borland's latest Turbo language: C++*

*No man is an island, even when surrounded by C. We start a new opinion column.*

*Some OOP building blocks for Turbo Pascal users.*

*Sequence, Selection, Iteration and...? The fourth kind of programming structure takes a bow.*



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**Editorial**

Editorial enquiries should be addressed to The Editor, .EXE Magazine, 10 Barley Mow Passage, Chiswick, London W4 4PH. We welcome letters, opinions, suggestions and articles from our readers. If you are interested in contributing articles, please write to this office for a copy of our Contributors' Guide.

Information contained in .EXE is believed to be correct. If errors are found, we will endeavour to publish a clarification in the next available issue.

From time to time, we offer to copy the PC program code described in an article onto diskette for our readers. In this case, please send a blank, formatted disk with a self-addressed, prepaid mailer to the editorial address given above. We can copy both 5.25" and 3.5" disks.

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**Pronunciation**

The name of .EXE Magazine is pronounced to rhyme with 'not sexy magazine'.

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What do the innards of Microsoft's latest pseudo OS look like? Peter Morris brings us up to date with the world of Windows.

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Verity has a family! Parity is as cynical as her sister.

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# Jules May doesn't use C

*Why is it that a language which disobeys all the established rules of language design is used for nearly all production programming? Jules May explains why he will never use C again.*

Programs are among the largest and most complex things that are built by people; the activity of producing a program is not easy at the best of times. In the process of doing something so hard, the tools one uses figure very highly in the success or failure of the project, and paramount among those tools is the language used to create the program.

It seems the national sport of programmers is to argue about which language is the best to program in. This is a game I totally fail to understand - the idea that there is a best language for all possible applications, or even for a single production program, seems entirely fatuous to me. However, there is such a thing as a worst language, a language which incorporates all the features of the oldest and most unpleasant languages ever built, with none of their advantages, and a few new wrinkles thrown in for good measure - such a language is C.

What do I mean by a bad language? It seems to me that a production program must work. No matter how ambitious the design, no matter what tricks have been used, no matter how good the user interface, if a program fails in use, it is badly made. Such failures need not be debilitating to make the program unusable; if a user spends five minutes thinking of a work-around and forgets his place in his job, that bug has cost perhaps half an hour of real time.

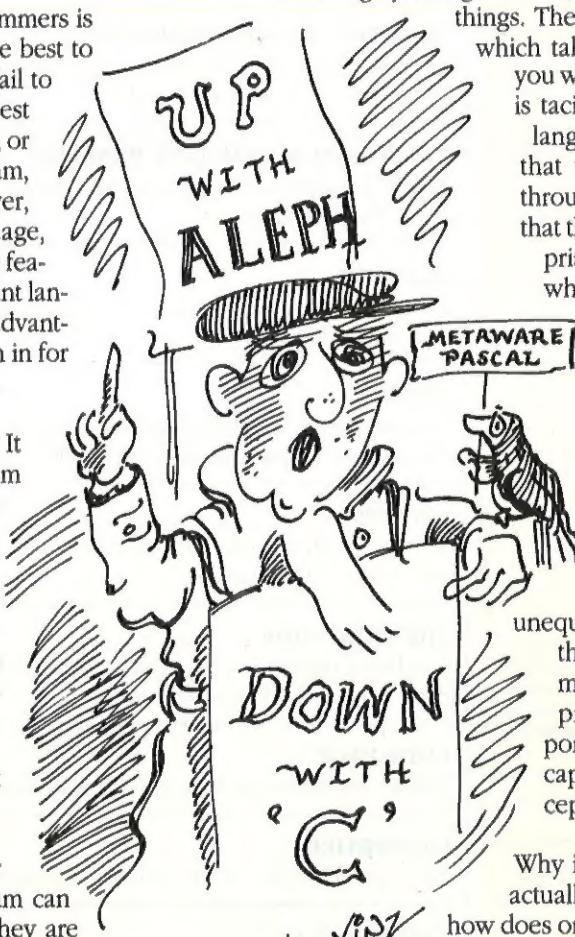
There are people who have built their careers on explaining why a program can never be made completely clean. They are wrong; it is possible to write clean programs, but not if you're writing in C. The C supporters claim that one is allowed access to the most secret parts of the machine. I agree, and I think this is a laudable feature in a language; my complaint is that one doesn't have the option not to. One can't think in terms of metaphors: one has to allocate memory explicitly, pass around its addresses explicitly, then deallocate it when one is sure one has finished with it. Every C programmer knows what happens when memory is deallocated prematurely; the resultant errors propagate around the computer until even the operating system is destroyed. How can anyone defend the concept of a compilable program being able to crash the operating system?

Computers were created to do boring, repetitive and precise jobs that are beneath human dignity. Jobs like turning references to reals into references to doubles. Jobs like checking that a variable passed by reference is not received by value. Jobs like deciding whether memory is in use or not. Jobs like making sure that a program stays decently within the bounds that the operating system gives it. C, you will notice, does none of these things.

The existence of programs such as *lint*, which takes a compilable program and tells you what you have done that is dangerous, is tacitly acknowledging the faults of the language. It is intrinsic to the language that you can pass almost any rubbish through the stack; the assumption is made that the programmer is able to take appropriate care at the receiving end, even when the receiver is in a different file from the sender - the actual file not being obvious from any piece of code, but with perhaps 50 to choose from on a significant project.

As if this were not enough, C programmers claim with perfectly straight faces that a language which is advertised as providing unequalled control over the deep levels of the machine (apparently to the detriment of all civilised behaviour), also produces code which is inherently portable. I do not understand a mind capable of believing both of these concepts at the same time.

Why is C so popular? Why would anyone actually want to write a program in it, and how does one get such a program to work?



*Jules May is a freelance programmer specialising in graphics and HCI. He also runs Jules Computer Ltd, a company marketing a 3D graphics sub-system which runs on a range of machines. In 10 years of programming, he has only produced one bug. He can be contacted on 0707 44185.*

*We are looking for contributors to this new column. If you have an opinion or idea that you would like to air here, please contact The Editor at the address given on page 1.*

## THE C LANGUAGE

**Microsoft C V6** is a complete rewrite with improved optimisation and a new Programmer's Workbench  
**High C V1.6** has been considerably improved, with better Microsoft C compatibility, and  
 new documentation

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We stock many items for which there is no space in these advertisements.	

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## THE C LANGUAGE

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### C CROSS COMPILERS

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## C++ Seminar a success



On the 12th June 1990, in London, AT&T attracted 154 members of the European software industry to 'C++: A Technical Seminar for the 90s', a one-day event sponsored by .EXE Magazine. The keynote speaker was Bjarne Stroustrup, the designer and original implementor of the C++ language.

Stroustrup spoke about his aims for C++, summarised the history of the language, listed the key characteristics of C++, described the new 2.1 release of the language, and summarised the relationship of C++ to C and the recently begun standardisation process, and introduced two extensions to C++ that are currently being worked on: parameterised types, and exception handling. He made it clear that C++ is a systems programming language, enumerating its many benefits, but admitting its inadequacies in areas such as knowledge engineering and artificial intelligence research.

Other speakers at the seminar included Dag Brück of the University of Lund, Sweden, talking about C++ as a research tool; Bill Chown of Mentor Graphics, which has, over the last four years, developed more than two million lines of C++ code; Steve Scrase of Solbourne Computer, talking about Solbourne's OI object library; Paul Ivin of Sun talking about their C++ debugger; and Steven Carter of the C++ standardisation committee. John Carolan of Glockenspiel Ltd gave his views on the pitfalls and potentials of the developing C++ market. The seminar concluded with a panel session, in which members of the audience put their questions to Stroustrup and the other speakers.

At the seminar, Stroustrup announced his new book on C++: *The Annotated C++ Reference Manual*, by Margaret Ellis and Bjarne Stroustrup, published by Addison-Wesley, ISBN 0-201-51459-1. It should be available by the time you read this issue.

This Summer will be a good one for OOP conferences. There also is Tools '90 in Paris, from the 26th through the 29th of June, and Scoop Europe in London from the 16th through the 18th of July. Scoop Europe is joint sponsored by .EXE Magazine: see you there.

Paul G Smith

## PDOS

PDOS is a real time operating system from Derby-based Eyrisoft. Version 4.0 has just been launched, featuring a new file system, a POSIX-compatible file interface, network support and increased system modularity.

The file system is described as a 'forest': it consists of multiple device names (which may represent, for example, hard disk partitions or network interfaces) each of which is the 'root' of a conventional hierarchical directory system. File hooks have been provided to support 'foreign' file systems, such as MS-DOS and UNIX disks.

The software is available immediately. There will be free updates to those who purchased PDOS in the last 12 months, and to those who kept their software support up to date. Eyrisoft is on 0332 384978.

## Novell Netware

Novell has produced V3.1 of Netware 386, its 32-bit real time operating system. Improvements over the previous release include open server APIs; a faster (claimed 25-30%) file system with support for third party drivers for removable media, such as CD-ROM and WORM; multiple name space support for different systems, so, for example, DOS users can access a 32-character Macintosh file with an 11-character DOS filename; disk mirroring increased to a maximum of eight mirrored drives; extended management services allowing detailed monitoring and controlling of network services and server resources; and EISA support.

The software should become available in July, from Novell's distribution channels. These can be determined by calling Novell UK Ltd on 0344 860400.

## Tartan Ada

The US-based Ada compiler developer is offering a limited number of free Ada compilers to deserving colleges and universities of any nationality. The compilers run on VAXs (VMS and Ultrix) and Sun-3 workstations. Details from Tartan on 0101 412 856 3600.

## Software Theft

A survey of senior British managers carried out by MORI on behalf of FAST (Federation Against Software Theft) found that 55% of the ones that used PCs admitted to copying software illegally. FAST estimates that over £300 million per annum is lost through illegal copying in the UK. FAST may be contacted on 071 240 6756.

## UNIX Stars

We mentioned before that Ritchie, D was attending the UK UNIX systems User Group's technical conference (11th-13th July); it turns out that other guests include Thompson, K and Kernighan, B. Get your copy of the White Book autographed! Three day attendance costs £373.75 inc VAT to UKUG members, membership costs £85.25. Contact 0763 73039 for further details.

## Bye Bye floppy

The 5.25" floppy diskette is on its way out - it's official. The MIRC Report 'World Data Storage Markets' states that unit shipments of 3.5" sized drives are now outstripping those of the traditional 5.25" drives. The report goes on to predict the emergence of 2-2.5" drives, particularly in lap-tops, and the rise of optical and DAT technology. The report costs US \$1495, MIRC is on 0101 415 961 9000.

## Legal Aid

City law firm Titmuss Sainer & Webb has produced a short guide to counterfeiting and piracy: the legal definition of these things and possible courses for redress if it happens to you. The guide is general - not software-oriented - but it is free on application. TS&W's number is 071 583 5353.

## Greek

If you want to run your Windows application in Greek, then you need a copy of DigiDuit. This will give you a choice of nearly 300 scaleable fonts (which you will have to buy as extras; you only get eight with the basic kit) which you can load into Windows and print on HP Laser compatible printers. Versions are also available to work with Ventura, Pagemaker, MS Word and WordPerfect V5. The supplier is David Pollard Associates (0865 240048).



## Shrouded in Mystery

It would be great to develop a general-purpose UNIX application, because there are so many potential customers. But since there is no binary standard for UNIX, one would have to supply C source code. If you supply C source code, you are relying rather heavily on your customers' honesty.

Gimpel Software, which I have mentioned before for its *lint* product, has come up with an application called 'The C Shroud', a 'source code obfuscation tool for the C programming language'. You write your program in the normal way, just packed with helpful comments and meaningful identifiers (word of *your* brilliant code style has reached the .EXE offices). When ready to ship, you pass it through the C shroud. Here is a piece of code pre-shrouding (left) and after the treatment (right).

```
#include "stdio.h"
#include "common.h"

main()
{
    int ch;

    while ((ch=getchar()) != EOF)
        output(ch);
}
```

```
#include "stdio.h"
void a286484(int);
main()
{
    int a72796;
    a117876:if((a72796=getchar())!=EOF)
        goto a106688;
    goto a77946;
    a106688:
    a286484(a72796); goto a117876;
    a77946: ;
}
```

The obfuscation includes comment removal, the conversion of high-level control structures into their *goto* equivalents, expansion of macros, identifier translation to randomised names and repetitive use of the same identifier sequence in non-overlapping name spaces (variables and structure tags, for example). All these features can be switched on and off as appropriate, so that the identifiers of library functions, such as *getchar()* in the example above, are left untouched.

The C Shroud is available for MS-DOS and OS/2 priced US \$198. Call the manufacturer direct for orders, and for prices for other machines. Gimpel's number is 0101 215 584 4261.

## C++/Views

C++/Views is a class library specific for Microsoft Windows (although it is intended, like Glockenspiel's CommonView, to be generic; versions for OS/2 PM, the Mac and X are promised). It contains over 60 classes including basic 'foundations', such as containers, collections, sets, dictionaries etc, persistent objects (implemented through an Archiver), serial communications and, naturally, lots of user interface objects such as dialogues, controls and so on.

But there is more. C++/Views contains some C++ development tools: the best is a class browser. This can handle single and multiple inheritance, source editing, multiple rooted hierarchies, adding and deleting object classes, member visibility options, application management and (it says here) much more. There also are tools for building dialogue objects and the aforementioned archiver.

If all this works even half as well as the sales-literature suggests, then this should be quite an interesting package. To get it to go, you will need a Windows-compatible C++ V2.0 compiler (ie Glockenspiel or Zortech) and a Windows SDK. The product costs US \$495, and at time of writing is available only direct from its makers, CNS, in the US (0101 612 944 0170).

## OOP Database

Ontos for OS/2 is an object-oriented database system. You can access it like a relational database, with embedded lines of SQL in your code. If you are working in C++, however, another avenue is open to you. Ontos supports persistent objects. By overloading the *->* operator, it is able to conceal much of the detail of the database operation.

The system works a bit like demand paging virtual memory. You write your data-manipulating code as though all the data that you require has been brought into memory. In fact, at each reference to a database object, Ontos's library code is called. If the data is already in memory, fine. Otherwise the database is searched for the relevant information. Naturally, it's not quite as simple as this; you do have to make various initialisation and transaction update calls as well, but the interface is much less cluttered than is usual for a DBMS.

Ontologic is also pushing a greater ability to handle complex data structures - for example, pointers and arrays may be included in the persistent objects - and a claimed performance improvement over conventional databases. More details from Ontologic on 0101 617 272 7110, or UK distributors Valbec Ltd (061 440 8231).

## Black, Magic Box

*Matrix Layout* is an application generator for MS-DOS. You create a flowchart, using a mouse-oriented, graphical interface; it spits out the application as BASIC, C or Turbo Pascal code. *Matrix Layout BlackBoxes* are function libraries which let you interface this system with dBASE files. These have just been introduced in the UK, and are being given away free with *Matrix Layout* V2.0 (£169 + VAT + delivery). Call *Matrix Software Technology* (0752 796363) for more details.

## Microsoft Project

*Microsoft Project* for Windows is a new graphical project management tool. It is completely GUI in design, and naturally you can cut and paste from the likes of Excel and Word for Windows. There are also links to dBASE and Lotus 1-2-3. The RRP is £495, upgrades from other versions of Project are offered at £120. The product should be available from dealers now.

## OS/2 EE

IBM has announced the availability of OS/2 Extended Edition V1.2 (the extensions consist of the Communications Manager, the Database Manager and the LAN Requester). This is the version that doesn't use the 80386 properly - for example, you can only run one MS-DOS application, which drops dead as soon as you switch to an OS/2 task - and so doesn't look particularly attractive as a GUI compared to Windows 3. Especially as it costs £611.

## EuroBIOS

*Eurosoft Ltd*, an independent European company, has announced the introduction of a 486/AT BIOS to complement its existing range of BIOS programs. Novel features of the BIOS include 32-bit data transfers between extended and conventional memory and a driver which performs EMS V4.0 emulation with extended memory. The company can supply the code in both ROM and binary file form, and it can be customised to your particular application. Details on 0202 297315.

## Czech Mate

We quite often get puffs for programmer's tools in the form of examples of famous applications built with them. Normally we ignore this material, but this story is quite amusing: the Czechs used FoxBASE to collate the results of their first General Election, held in June. Bet you thought it was just for sorting the Customer Order file.

# An object lesson in programming

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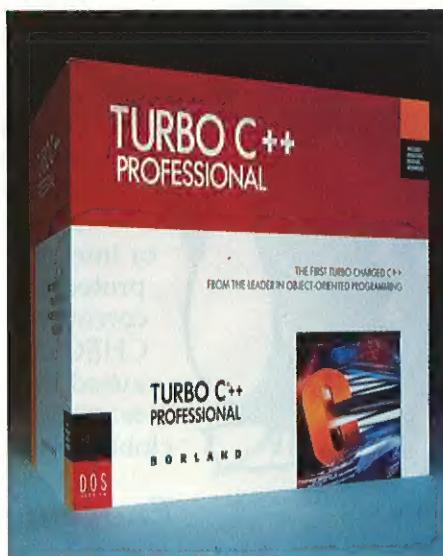
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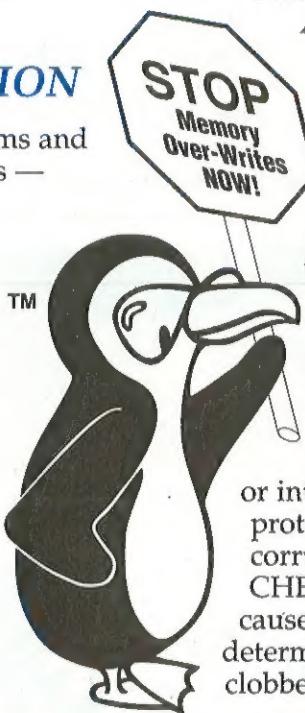
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CIRCLE NO. 064

## Mercurial dBASE

Quicksilver/UNIX is a dBASE (III+ and IV) language-compatible compiler that has wandered into Fox Software's lair: it runs under PC versions of UNIX, such as SCO UNIX. The compiler produces native executable code, which can be executed without a run-time environment. According to the distributor, it is also dead quick. Data files are binary compatible with MS-DOS dBASE files; all you need to do is copy them from one system to the other. Extra features include a text windowing system, 512-field 4000 byte records, arrays with up to 255 dimensions (prize competition: a .EXE T shirt to anyone who can describe a sensible application for a > 10 dimension array; entries should be sent to The Editor) and better record locking - as one would hope when porting from MS-DOS to UNIX. A symbolic debugger reduces the wrench from an interpretive to a compiled environment. Limitations include the loss of interactive commands such as EDIT, BROWSE and MODIFY STRUCTURE.

Quicksilver/UNIX is distributed by Willaire Electronics PLC (0494 465 234). The package retails at £795.

## Lattice Out

Lattice has released its 80286 C development system for MS-DOS and OS/2. What makes this compiler unusual is that it incorporates a 286 DOS extender. Code that is developed with the extender does not need a run-time licence, so in effect the thing may be used just like an ordinary DOS compiler. The package also includes a source level debugger, an editor, a linker and the biggest 'give-away' library that you will see with a DOS compiler - I know because I looked at it when reviewing the company's standard C compiler. There is yet another feature to this compiler which you don't see often - and not as big a selling point, I fancy, as the other things that I have mentioned. It's dongle-protected.

The US price for the package is £495. Lattice is offering various upgrade bargains to owners of previous versions of its compilers. You may want to hang on for the 32-bit 80386 Lattice C compiler, which is due out soon. Lattice's UK distributor is Roundhill Systems: 0672 84535.

## Check it with QCheck

There is no way to test any non-trivial application completely, but a good start is to make sure that every line of code has been run at least once. QCheck is an MS-DOS utility that helps you do exactly that. You compile and link your program to produce a Microsoft-compatible .MAP file with source code line numbers in it. You run the program under QCheck (which operates like a debugger), and can use a hot-key system to display, at any time, the source with *unexecuted* lines highlighted. If it's an interactive program, you can adjust the test input until you have forced an occurrence of every case.

When you have finished, QCheck can produce a listing of the source with the untested lines marked - just the thing to wave under the nose of the QA man. The drawback, of course, is that QCheck lives

in the same memory as your application, occupying 39 KB + 17 bytes/line of test program, and so restricts the size of program that can be tested.

QCheck is produced by Seltek Software, and costs £155 + VAT. Seltek's number is 088 341697.

## HP's C++

Hewlett Packard has produced a new development environment for C++. HP C++/Developer can be used in conjunction with HP's SoftBench environment, or as a stand-alone X-Window application. You need the graphics support because C++/Developer includes a graphical class browser and class construction facility. There is also an automatic MAKE file generator, and a cross-referencer. Details of prices and platforms from HP on 0344 369369 (and quote reference 4363).

## Hyphen

Here's a C library the like of which you will not have encountered. It's very easy to describe the action of Hyphenologist: you pass it a string containing a word, it returns an array containing pointers to the places in the word where it can be hyphenated. That's all. It's rather more difficult to do, though.

For one thing, it depends on the language that the word was written in. Hyphenologist supports forty one languages (you try naming forty one languages) including English (phonetic and traditional), French, Italian, Latin, Lithuanian, Greek and Russian. The package is intended for writers of word processing, typesetting and DTP packages; it is the nichiest example of niche marketing that I encountered in the software industry.

Good luck to Computer Hyphenation Ltd (0274 733317), whose product is supplied in K&R C source form and costs from £2500 upwards - it depends on how many languages you want.

## Disc-Lock

Disc-Lock is an MS-DOS utility which password protects a PC's hard disk. When locked, it prevents the user from getting out of an application and into MS-DOS, however hard he may press Ctrl-Break or tries to shell out. Its intended for corporate and public service use, where PCs need to be protected from unauthorised use. Disc-Lock costs £78 from Visionsoft (0274 610503).

## Zephyr

Zephyr is 'a fully-relational, FoxPro-compatible DBMS for non-programmers'. According to the distributor, Advantage (0242 224340), it blends the best features of dBASE, FoxPro, Oracle, SuperBase IV and Alpha Four. Cor! You don't have to take this on trust, however, as there is a demo version, limited to 120 records, available for £6.95. The full package costs £59.95.

## Paradox Brief

TCC (0978 290167) has linked the Brief Programmer's Editor into the Paradox Integrated Environment. You can edit PAL scripts from within Paradox, moving directly to the line being debugged. It will also look after your indentation for you. TCC will charge you £159 for a copy of Brief thus modified; £40 extra for a PAL template editor as well.

## It did not die

Owners of Turbo Prolog V2.0 may like to know that, despite Borland's abandonment of the product, development continues. The original devisers of the product, a Danish software house called the Prolog Development Centre, has now produced version 3.2. You can upgrade to this for about £55; and there are also toolkits and a news-letter to see. Call PDC on 010 4536 721022. Don't worry - their English is better than mine.

## DPMI

The DOS Protected Mode Interface is a new commercial standard which is being set up between such key companies as Borland, Eclipse, Microsoft, Phar Lap and Quarterdeck. It will allow multi-tasking DOS applications to share extended memory, and is the follow-up to the VCPI standard for compatibility between EMS emulators and Extended DOS applications.

## Trojan Zip

Bulletin board users should look out for a program claiming to be V1.2 of the popular archiving program PKZIP. This is a Trojan, and should not be used. There is no legitimate V1.2 of PKZIP - and never will be.

# Letters

We welcome short letters on any subject that is relevant to software development. Please write to *The Editor, .EXE Magazine, 10 Barley Mow Passage, Chiswick, London W4 4PH*. Unless your letter is marked 'Not for Publication', it will be considered for inclusion on this page.

## Bugged!

Sir,

In his article on the 80386 protection mode in the May '90 issue of .EXE, David Bailey raised an interesting point which I have found useful. However, a minor correction is needed to the program in Figure 1, in order to avoid a bug that can be potentially dangerous. The bug is caused by the program not attempting to save the second interrupt controller mask before calling the BIOS service INT 15h. The attempt to save the first interrupt controller mask (as the program does) is not sufficient to preserve the state of the interrupts. The following code should be included before and after calling the BIOS service to remedy the problem:

```
;Before calling the BIOS
;read the mask
IN AL, 0A1H
;save it
MOV byte ptr int.mask2, AL
; After calling the BIOS
MOV AL, byte ptr int.mask2
OUT 0A1H, AL
```

Dr K S Sabri  
Douglas Electronics  
Gwent

## Unprintable BASIC

Sir,

I have used Microsoft BASIC V7.0 for about two months. I am, on the whole, delighted with the improvements over V6.0b. However, I have also discovered several problems, all of which I have referred to Microsoft without having to elicit a single useful answer.

In one case, a large, multi-module application, which works perfectly under V6.0b, crashes at random intervals into DOS with the message 'unprintable error'. This despite the inclusion of a catch-all ON ERROR routine in my source.

Another problem concerns the use of expanded memory within the QBX envi-

ronment, about which I have little to say beyond that it does not appear to work as claimed.

In addition, the LINK switch /exepack produces a .EXE file which locks my computer.

Letters, faxes and telephone calls to Microsoft produce a fixed standard reaction: someone looks up their database and quotes the contents thereof, irrespective of whether or not they are relevant to the specific question. No answer received over the last two months has had any useful content.

Further on the subject of Microsoft BASIC, I am still hoping the User Group BASIC conference will, one day, be reinstated. I booked for the one last year that was cancelled without explanation. I have been programming in BASIC for 10 years and have yet to discover a forum for the exchange of ideas in that language. Any suggestions?

Michael Gilbert FRICS  
KEL Computing  
Bourne End

*Mr Gilbert included further details of his problems, which are too lengthy to be printed here. Interested parties should apply to the editorial office for a copy.*

## dBASE Guide

Sir,

Do you know of an on-line guide for dBASE III+, similar to Norton Guides? If so, please could you send it or let me know how much and where to get it?

Ron Nixon  
Sigma Software  
Southampton

*We rang Norton UK who said that Simon & Schuster (0442 231900) were dealers for an on-line help package for dBASE III. When we contacted Simon & Schuster, however, their representative confirmed the existence of the package in the USA, but said that the*

*company had not yet reached agreement with Norton US to distribute it over here.*

*For the time being, however, you may like to know that Nantucket distribute a product called SOS Help which is intended to work with the similar Clipper.*

## Chip Problem

Sir,

There appears to be a bug in some, if not all, 80386 and 80386SX processors which I've encountered. It is manifested during segment manipulation, and does not appear to be documented in any Intel manual that I've seen.

Briefly, if a segment register is MOV'd to a 16-bit general purpose register, the top 16-bits of the corresponding 32-bit register are corrupted. So, the instruction MOV AX, SS will corrupt the top word of EAX.

I haven't had the chance to check this with an 80486 processor.

Rupert Goodwins  
Alfa Systems  
London

## Disgruntled Turbo

Sir,

I have been using Turbo Pascal for nearly a decade. Over the years, I have built up a considerable library of code. Recently we purchased a SQL C API. In my naivety, I thought I'd be able to link Turbo C modules and Turbo Pascal units. I can't, unless I use Turbo Pascal V4.0, for which Borland had a .TPU to .OBJ converter, and even then I can't change the heap manager because I can't get the TP4 runtime library source.

Borland's position seems to be: tough. I think this is madness. I produce what Philippe Khan is pleased to call 'mission critical' applications, and I want to use my libraries. I can't, unless I rewrite them all in C. It's simply shoddy; and the release of C++ makes convergence even harder.

Jason Fordham

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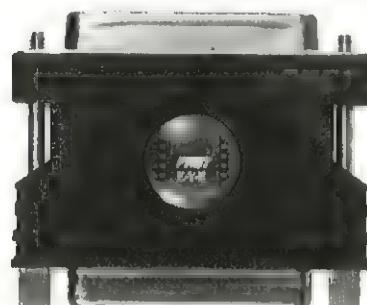
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CIRCLE NO. 065

# Inside Windows 3

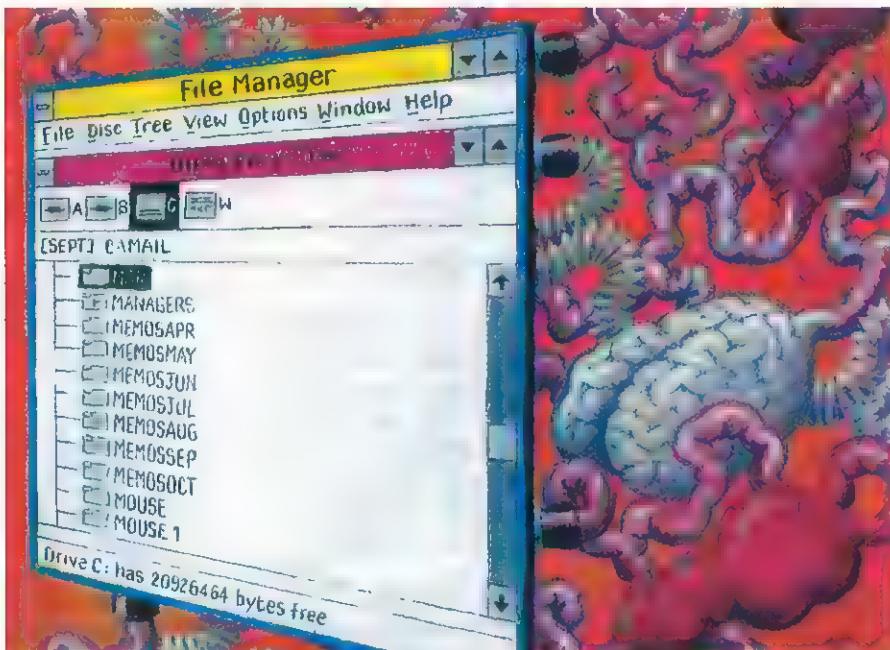
*Handsome, bas-relief Microsoft's Windows 3 looks destined to become the wow of the Lotus 1-2-3 eating set. Peter Morris gives a technical introduction to its tricks and traps.*

What's new in Windows version 3.0? Well, the biggest differences are in the types of memory, the use of both real and protected processor modes and a revised memory management system.

Whether your PC's RAM is conventional memory (ie directly addressable by the 8088/8086 processors), expanded (paged in memory) or extended (memory above the 1MB line, addressable by 80286-80486 processors running in protected mode), Windows doesn't mind. Plain vanilla DOS applications also may access all these types of memory from within Windows - essentially Windows utilises your machine's memory to the full, whatever it may be. There is enough subject matter in Windows' handling of these memory types, DPMI etc to fill a whole article, but, for now, let's move on to modes and memory management.

Windows 3 has three distinct modes of operation: real, standard and enhanced. Standard and enhanced modes work by running your 286/386 processor in its protected mode, and it's in this mode that up to 16 MB of extended memory becomes available. If you have a 386/486 machine, Windows' enhanced mode can also use disk space as virtual memory. At the other end of the scale, real mode, the processor (irrespective of what it is) is run in - you've guessed it - the real mode, allowing access to just 1 MB of address space.

DOS applications running under Windows may take advantage of all the different types of memory available in your PC (although some are only available in certain modes). If you're using a 386/486, each DOS session/application can be run in a separate virtual 8086 machine. These applications may be as badly behaved as they like; for example, they may attempt to write directly to video memory. Under enhanced mode, text mode DOS applications may



even be run in a window. As far as the application is concerned, it is running on an 8086 with 640 KB of memory (although extended, expanded and virtual may also be used, if the application knows what to do). Attempts to write directly to video memory are trapped. Windows runs a 'text mode emulator' in the window it has pro-

vided for the application (Windows itself, of course, runs in graphics mode), and it's here (and only here) that the application's output may appear. The system is very robust: you can install TSRs, and even cut and paste from the DOS window to the clipboard. What's more, these virtual machines may be pre-emptively scheduled - ie the PC

```
#define ONE_K 1024
GLOBALHANDLE hMem;           // memory handle LPSTR lpDemo;
// far pointer
hMem=GlobalAlloc(GHND,ONE_K); // get 1K
GlobalReAlloc(hMem,ONE_K,GMEM_ZEROINIT); // add 1K
lpDemo=GlobalLock(hMem);
... // access memory data here
GlobalUnlock(hMem); // implicitly invalidate pointer
GlobalFree(hMem); // implicitly invalidate handle
```

Figure 1 - Common misuse of GlobalRealloc()

can run several DOS applications (and keep them running using time-slicing techniques).

## Programming

Time to have a look at some programming issues; in particular, how to write programs for protect mode Windows applications, and how to go about converting a Windows 2 application to work under Windows 3. I should start by saying that the Windows 3 API is a superset of Windows 2, so there are no functions which 'no longer work'. That is not to say, however, that Windows 2 applications are automatically upwards compatible.

Microsoft says that applications wanting to run under Windows 3 (standard and enhanced modes) should be 'protect mode aware'. At QA Training, we would say that such applications were simply API aware and conventional! For example, one of the changes that trips people up is to do with the routine `GlobalReAlloc()`, which reallocates an area of memory in the global heap. Here is what the manual says about `GlobalReAlloc()`'s return value:

*'...the return value identifies the reallocated global memory if the function is successful. The return value is NULL if the block cannot be reallocated.'*

Judging from this, it would seem essential to record the return value for subsequent use. However, under earlier versions of Windows, it was possible to ignore the return, as `GlobalReAlloc()` always passed back the value supplied to it in the argument `hMem`. Take a peek at Figure 1 to see how this was done.

This approach worked fine under Windows 2.x. The handle `hMem` never changed value during the call to `GlobalReAlloc()`, so the reassignment wasn't needed. Conscientious programmers may have used the return to check for an out of memory failure, but it certainly was not needed to access the reallocated memory block.

Many programmers discovered this 'implementation specific' feature (Microsoft's code examples use it all the time) and built reliance upon it into their code. This code will now need modifying, as the handle's

## Windows 3 - the main changes

There is much better use of hardware - the CPU's protected mode, the various types of extra memory.

- There is a new control, called 'COMBO', which combines edit and list control.
- The existing controls have new functionality.
- There is a sophisticated Help manager, and a standardised Help file format.
- There are much improved colour-handling facilities, with a Palette manager
- There is an improved API, with more functions and greater capability.
- The new '3D' front end - the buttons now appear to move in and out when you click on them.

There is a new set of tools to go with Windows 3.

There are also other, minor changes.

value is (sometimes) not maintained. (It all depends on whether the data segment crosses a 64 KB boundary during reallocation. In protect mode, this is catered for by a technique called 'selector tiling'). The correct technique is illustrated in Figure 2.

Another facet of 'Protect Mode Aware' programs is that they must not do segment arithmetic. In real mode, where far pointers comprise of a segment and offset, it is possible to bump a pointer forward 16 bytes by incrementing its 16-bit segment component. Under protect mode, far pointers aren't what they seem; any attempt to do something like this will result, at best, in a protection violation. This is because the segment part of a far pointer is not an address value, but a pointer to a descriptor table entry. It is this entry which holds the paragraph address of the object we are trying to point to. If you're familiar with the Windows 'thunk' mechanism, it's like having a reload thunk for data. Thus, an attempt to increment the segment part of a far pointer increments the pointer into the descriptor table. You can do this, but it is certainly not what you meant, and it is desirable to catch this situation. Protect mode is made for this sort of stuff.

Here is a further side effect of protect mode. Applications that need multiple data segments (none of them do, in point of fact) no longer have to lock them down. The whole notion of 'segment locking' is nonsense in protect mode - you just tell if a segment has moved, locked or not. This means that compact, large or even huge memory model applications may now be written without fear of

system performance degradation - provided that they are used in protect mode only. By the way, Microsoft says that medium memory model applications should still be the norm, as your users may be using Windows 3.x real mode. Read on...

If Windows needs to move a data segment (we'll say of a multiple data segment application) it can now relocate the segment without worrying about the effect on your application. For example. You have a pointer to a piece of local data (by far reference) and Windows needs to move the data. All it has to do is change the entry in the descriptor table (referenced by your pointer's segment word) so that it points to the base address of your data segment. Your pointer has the same value as before, but the object to which it points has moved, relative to the real memory map. It's one of those 'frame of reference' conundrums.

One other thing I should point out here. You'll notice in Figure 1 that I've included comments such as 'implicit invalidation of pointer'. You should always *explicitly* invalidate pointers and handles to now defunct or extinct objects when you're through with them. There should also be routines to 'validate' these objects prior to their use. If you use this technique, it should be impossible for you to use invalid references or objects (either direct or indirect references).

To implement this idea, most serious Windows programmers devise their own 'home-made' versions of the allocation/locking, freeing and validation routines - mine are shown in Figure 3. The routines could be placed in their own DLL. They perform the function of the 'real' API routines (eg unlock some memory), but they also explicitly invalidate any defunct implicit pointer or handle. Before using a pointer or handle, you call a 'validate' to check that it's ok.

```

hMem=GlobalAlloc(GHND,ONE_K); // get 1K
hMem=GlobalReAlloc(hMem,ONE_K,GMEM_ZEROINIT); // add 1K
lpDemo=GlobalLock(hMem);

```

Figure 2 - Correct use of `GlobalRealloc()`

# FINALLY. A debugging tool tough enough to handle the DOS Nasties.

New Version 2.0



## Nasty over-write? No sweat!

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Figure 3 - Home-made memory allocation routines

```

BOOL ProtectLocalAlloc(WORD wFlags, WORD wBytes, HANDLE *hMem)
{
    return (*hMem=LocalAlloc(wFlags, wBytes)) != NULL;
}
BOOL ProtectLocalLock(void NEAR *pMem, HANDLE hMem)
{
    return ((*pMem=LocalLock(hMem)) != NULL);
}
BOOL ProtectLocalUnlock(void NEAR *pMem, HANDLE hMem)
{
    return ((*pMem=LocalUnlock(hMem)) == NULL);
}
BOOL ProtectLocalFree(HANDLE *hMem)
{
    return ((*hMem=LocalFree(hMem)) == NULL);
}
BOOL ValidateNearPointer(char NEAR *pMem)
{
    return pMem!=(char NEAR *)NULL;
}
BOOL ValidateHANDLE(HANDLE hMem)
{
    return hMem!=(HANDLE)NULL;
}

```

## Handle Abuse

I have a great wrench for dyed-in-the-wool sloppy programmers. You really are going to have to stop casting memory handles to pointers. (You might also like to stop using C, but let's do one thing at a time.) Would you treat an integer like a real? Would you treat a cow like a dog (perhaps by feeding it beef offal)? Quite. So why treat handles as pointers? Come on, guys and gals! This is an object-oriented environment that we are using here. If you respect the implementa-

tion's privacy, your client code will never be broken.

Let's take a look at the sort of situation that leads us into temptation. Figure 4 shows the correct way to generate heap addresses, Figure 5 the wrong way. Needless to say, the code in Figure 5 works. (Where do you think it was first seen? Yes, you've guessed it, Microsoft code.) It's wrong because we are using knowledge about the implementation of a handle object to bypass the LocalLock() and LocalUnlock()

calls. LocalLock() takes a handle to a memory object, locks it down, then returns the address of that object in the local heap (this 'lives' within the application's default data segment). In the 'implementation specific' code, the handle is de-referenced using our ill-gotten knowledge. However, the object must be prevented from moving - we must simulate the effect of LocalLock(). This is done by asking the local allocator to supply a 'fixed' object. In the Figure 5, there is a call

```

LocalAlloc(LPTR, ...);
where LPTR = 'Local
Pointer' = LMEM_FIXED |
LMEM_ZEROINIT is set up in WIN-
DOWS.H.

```

WINDOWS.H also contains the definition of a GPTR constant, which suggests that the same dirty trick may be done on global objects. This is indeed the case, as you can see in Figure 6. You take the result of calling the global allocator and zero, turn them into a long, cast that to be a far pointer to WNDCLASS and assign the result to lpGlobalMemory.

You shouldn't do this, no matter what Microsoft does. Apart from the importance of treating objects as objects, and not as segment addresses, there is one real nasty thing about this allocation code. It's not checked for validity within the expression, or even after it's been initialised. Consider what will happen if the GlobalAlloc() request, which returns NULL on failure, goes wrong.

Try the Figure 6 trick while running under one of the Windows 3 protect modes, and you will find yourself looking down the wrong end of a GP violation (best case) or accessing the wrong global segment (worst case). Remember, the segment part of a far pointer is now a segment selector. It is theoretically possible to fabricate a far pointer from the selector and an offset, but if you try and use a memory object allocated by GlobalAlloc() without first calling the GlobalLock() function, a GP error is the best that you will get, and it's more than you deserve.

## Marking

Applications written under Windows 2.x may be identified as being 'protect mode aware' using the Windows 3 SDK 'mark' utility. Normally, if you attempt to run an application created using an earlier SDK version, with Windows 3 in either standard or enhanced mode, you'll be warned that it isn't protect mode aware. (In fact, the actual message displayed says 'this application was written

```

// LOCAL OBJECTS:

LOCALHANDLE hLocalMemory; // handle to local memory
NPWNDCLASS pLocalMemory; // pointer to local memory

// need something the size of a WNDCLASS from the heap.

hLocalMemory=LocalAlloc(LMEM_ZEROINIT,sizeof(WNDCLASS));

if(hLocalMemory)
{
    pLocalMemory=(NPWNDCLASS)LocalLock(hLocalMemory);
    // get address from handle by locking handle
}
else
{
    // deal with "didn't get local memory" error
}

// process memory here, for example
// pLocalMemory->lpfnWndProc=MainWindowWndProc;
// etc
//

// free up memory

LocalUnlock(hLocalMemory); // implicit invalidation of
                           // pointer pLocalMemory

LocalFree(hLocalMemory); // implicit invalidation of
                        // handle hLocalMemory

```

Figure 4 - Correct way to generate local heap addresses

*Figure 5 - Wrong way to generate local heap addresses*

```
NPWNDCLASS pLocalMemory; // pointer to local memory
// need something the size of a WNDCLASS from the heap.
pLocalMemory=(NPWNDCLASS)LocalAlloc(LPTR,sizeof(WNDCLASS));
if(pLocalMemory)
{
    // process memory here, for example
    // pLocalMemory->lpszName=MainWindowWndProc;
    // etc
}
// free up memory
LocalFree((LOCALHANDLE)pLocalMemory);
```

*Figure 6 - Wrong way to generate global heap addresses*

```
LPWNDCLASS lpGlobalMemory;
lpGlobalMemory=(LPWNDCLASS)(MAKELONG(0,
    (LONG)GlobalAlloc(GPTR,sizeof(WNDCLASS)));
//... use the pointer here
GlobalFree((WORD)(DWORD)lpGlobalMemory));
```

for a previous version of Windows', but it really means that it isn't protect mode aware.) You are given the choice of either restarting Windows 3 in real mode (typing the command line 'win /r' does this) or pressing 'OK' to carry on regardless. A long study of human nature leads me to suspect that most people will take the latter course. If you have written a Windows 2.x application, and you know that it's protect mode aware, then you can mark it as such with 'mark', and the warning message will be suppressed. Nor will it appear if you develop your application with the Windows 3 SDK - but note that, as we have seen, use of the current SDK in itself does not prevent you from writing 'protect mode blind' applications.

Another conversion catch: Windows 3.0 uses a non-fixed pitch system font. If you have used spaces to line up the strings in your .RC files, then you will need to modify them. Figure 7 shows an example of this sort of problem. If the text strings are left as they stand, they would display something like this (whichever mode is used):

**First item Ctrl+F**  
**Second item Ctrl+S**  
**Third item Ctrl+T**

To get this right under Windows 3, you will need to align things using \t tabs:  
 MENUITEM "&Whatever\tCtrl+W",
 ID\_WHATEVER

Windows 3.0 applications must be aware of the proportional font if a professional effect is to be obtained.

utility that comes with the SDK. The segmented executable linker is simply a later version of LINK4. If you do use it, however, you must include the following in your .DEF files:

```
NAME TEST
DESCRIPTION 'test application'
```

```
EXETYPE WINDOWS
```

It's the EXETYPE line that is important. Incidentally, you can add this line to all your old .DEF files if you like, as LINK4 ignores the EXETYPE directive.

## Conclusion

There are other things that you need to know, but there is not enough space to tell you about them here. The key is remember to (keep banging the rocks together?) treat the API with respect and make your code conventional. Writing your applications in a different language than C would help - general-purpose programming my language my foot! (*That's quite enough whinging about C for this issue - Ed.*)

Perhaps an approach based on a UIL (User Interface Language) will come along soon, and make everything easier. It seems like common sense that these applications should be written in some sort of GUI language, and not by calling routines in a library. Meanwhile, my advice is to use anything that helps you master the ever-widening API and its associated programming problems.

[EXE]

---

*Dr Peter Morris is the Senior Windows Lecturer at QA Training (0285 655888). He has been teaching Windows 3 for many months.*

---

*Microsoft Windows 3 costs £99, and is available from dealers now. The Windows 3 Software Development Kit will start shipping during July.*

```
#include "style.h"

#define ID_ONE 1
#define ID_TWO 2
#define ID_THREE 3

TestMenu MENU
BEGIN
    MENUITEM "&First item" Ctrl+F", ID_ONE
    MENUITEM "&Second item" Ctrl+S", ID_TWO
    MENUITEM "&Third item" Ctrl+T", ID_THREE
END
```

*Figure 7 - Unmodified resource file*

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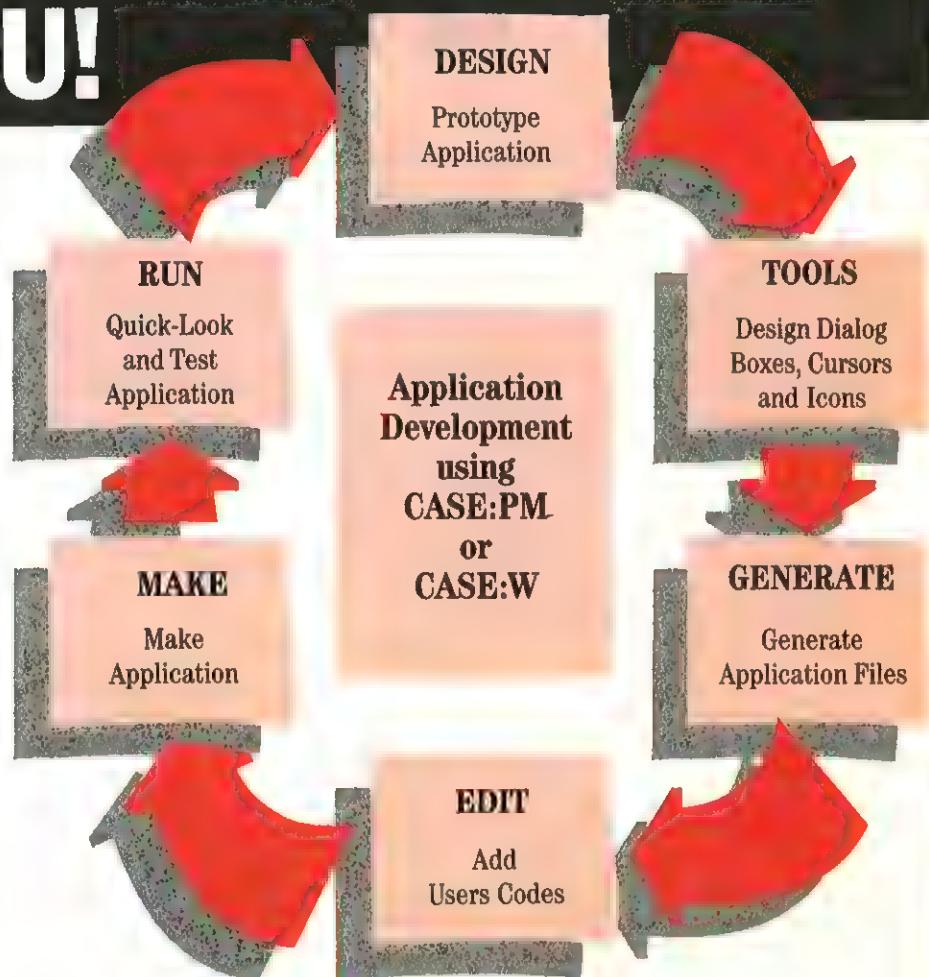
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CIRCLE NO. 067

# Red is the Colour of Turbo C++

*Turbo C++ has ended its career as vapourware. Willie Watts has been taking a look at the latest compiler from the Borland stable.*

Borland likes to see itself as the populariser of esoteric languages for the common programmer. Before Turbo Pascal, the Pascal language was an educational tool, running on college mainframes and the occasional Apple. The few PC translators that existed huffed and puffed to produce greasy, corpulent object code that sometimes ran almost as fast as the BASIC interpreter that came free with the machine. Post-TP, some of the reference books now describe Pascal as a 'real time language'; if that isn't Borland's fault, it's difficult to see who else to blame.

But wait. This has not been a story without a hitch. More recently, Borland introduced Turbo Prolog. This was a non-standard implementation of the language (doubters who pointed this out were brushed aside with cries of 'Turbo Pascal was non-standard, too') which was to be the first really pragmatic version of Prolog. Artificial Intelligence had been made accessible to the PC user. About six months ago, Borland announced that it was returning the rights of this product to its original owner. Owners of Turbo Prolog were left, if not entirely up the creek, then certainly a fair distance from the estuary.

Turbo C++ is different. It is, relatively speaking, much more important to the company's success: of its surviving lan-

guage product lines, Turbo C++ represents half. However, despite Borland's description of itself as 'the leader in object-oriented programming' this is its deepest foray into the territory (last year's intermediate release of Turbo Pascal carried a strong hint of anti-QuickPascal marketing, and rather less OOP technology). Will the company hold firm when the inevitable anti-OOP backlash begins? The spectre of Turbo Prolog has yet to be exorcised.

## What you see

Turbo C++ comes in two flavours: 'straight' C++, which consists of the compiler, integrated environment and associated tools and the 'Professional' version, where you also get the latest version of Borland's deservedly famous debugger, an assembler, and a new profiler. These tools are also available separately and, owing to constraints of time and space, this is how I shall be reviewing them. This review, then, confines itself to what we might call 'Turbo C++ Amateur'.

Red, for those of you who have been wondering about the melodramatic headline at the top of this piece, is the dominant colour of Turbo C++'s box and manuals. The software comes on eight 360 KB disks (Microsoft now supplies 1.2 MB as standard, and invites those without AT drives to send off

for an alternative disk set) stored in compressed format. An easy-to-use and business-like INSTALL program moves the stuff onto your hard disk in short order; you get to nominate the target directories, which memory model libraries that you want and so on. An omission is that, unlike some rival's recent efforts, the program does not report exactly how much disk space your selection requires before it starts; it merely states that the maximum is about 6MB. The configuration that I chose - small and large library memory models only, plus everything else in the way of examples and tutorials - occupies 5 MB.

With everything gathered safely on board, time to load up the integrated development environment, which is still called TC.EXE, despite having been renamed the Programmer's Platform, if you see what I mean. The IDE (as I shall stubbornly continue to call it) has been entirely reworked. That influential Chinese-born designer See-Yu Ay has been let loose among the hallowed keystrokes and menus of Turbo C. Having been comparatively slow to acknowledge the onset of the mouse, Borland has now introduced it with vengeance.

Mouse-friendly means keyboard-hostile, at least to start with. You constantly find yourself hitting ENTER where you meant TAB, operations that used to take two keystrokes

	register int	auto short	auto long	int multiply	function	auto double	compile time (secs)	.EXE size
Lattice V6.0	0.31	0.35	0.98	1.23	1.61	27.1	26	27646
Microsoft V6.0	0.33	0.33	1.7	0.32	1.1	49	35	32310
TopSpeed V1.0	0.26	0.26	0.83	1.42	1.27	51.6	12	27590
Turbo C V2.0	0.35	0.38	1	1.2	1.1	110	6	27348
Turbo C++ V1.0	0.34	0.35	1.16	1.18	1.15	97.8	10	27552
Watcom V7.0	0.24	0.24	0.75	1.2	1.1	8.02	27	18119
Zortech V2.0	0.31	0.31	1.04	1.2	1.16	18.7	14	24160

Except for compile time and .EXE size, the results are shown in microseconds per individual operation, using a 20 MHz 386 machine.

Figure 1 - Plum Hall C Benchmarks, with compile time and file size.

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Byte Magazine, May 1989

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(loading in the file-before-last, for example) now seem to take loads. There are some neat new features - a 'history' function lets you step back through your previous selections of search/replace and file selection mask strings - but I am sure that the net change is an increase in clumsiness of use. I am uncomfortably aware of the high subjective element in this judgement, and apologise for it. My guess is that current users of Microsoft Quick... languages will like it better than current users of the Turbos.

Anyway, at least the default editing keys are still Wordstar (function key assignments have changed slightly), you may tamper with the setup if you wish. The editor supports a simple macro language - but you have to compile text files with a separate macro compiler; there is no macro recording facility. You can use this language to 'wire in' other programs into the environment. (If you get really keen on the IDE, you can even write a filter program to let it track error messages output by another compiler). There is now a clipboard mechanism for manipulating blocks of text - it is half-way between the Wordstar approach (where the block that you manipulate is highlighted) and the EMACS/Quick... compiler approach, where you move text in and out of a hidden buffer. You can cut text from the context-sensitive help and paste it into the edit buffer. You cannot, however, cut from an arbitrary section of the screen - for example, the DOS output window.

The new system for managing projects - the IDE's equivalent of a MAKE function - is definitely an improvement, although old

Borland hands may have to fight with it a bit at first. Turbo C V2.0 .PRJ files had to be typed in manually as text, and consisted of a list of sources and .OBJS, one per line, to be used in the project. Dependencies had to be placed next to the name of the file that used them. The new system automates all of this. You can just click on your selection from the list of files and it is added to the file. The IDE finds all the dependencies for you, so you can now use it to browse through the #include files that you have sucked in. Compiler options are stored in the project file; you can specify a global default for compilation switches and file-by-file exceptions. There is a facility to use the 'wired-in' external translators mentioned above, so you can incorporate that module written in Pure Dorset LISP into your C++ project.

The feature that may confuse newcomers is that the setup of desktop windows is stored in the current project file. When you switch projects, all your windows suddenly close themselves down, then reopen somewhere else with different contents. You can also store textual notes in the project file but, as you will have deduced, it has a binary format, so can only be altered by the IDE. Utilities are provided to convert Turbo C .PRJ files to Turbo C++, and also to generate conventional MAKE files from TC++ .PRJ files.

The IDE debugger has been fixed up a bit; it now has conditional breakpoints and an inspection facility that handles arrays, structures and classes. Borland has not put too many features into it, however - remember it intends to sell you the separate Turbo

Debugger.

A final note about the IDE. It manages to squeeze a lot of code into the MS-DOS environment (it does contain a C++ compiler, after all) and yet can still compile reasonably sized code modules. How does it manage this? By making extensive use of Borland's overlay system VROOMM (Virtual Runtime Object-Oriented Memory Manager). You can generate your own VROOMM applications with this package, so a more detailed description is in order. Modules (called 'segments') to be overlaid are compiled with a special switch. Stub code is generated for all the segment's entry points. When the program is run, calls to the stubs go to an overlay manager, which determines whether the required segment is currently loaded. If it is, the call is passed on. If not, the segment is loaded from disk. If there is insufficient pool memory to allow it to be loaded, discard loaded segments. Note that, using this scheme, overlaid functions can call each other, so the setup requires minimum programmer effort to function. Note also that segments may be discarded to expand or extended memory, permitting very frosty reload times when their turn next comes around.

## What you get

The compiler, or rather the compilers, for there is a different parsing/front-end mechanism for C and C++, is/are integrated into the environment seamlessly, thanks to VROOMM. I mention this because, if your first experience of an integrated environment was Microsoft C V6.0 PWB running under DOS, you might have gained the impression that they are mostly about staring at the screen while the compiler swaps itself in and out. (Incidentally: MSC6 users, the word on the street is that the cure, ha-ha, is to run PWB under OS/2.) It has been a traditional feature of Borland's languages that small files compile almost instantly. I am pleased to report that this feature has been maintained, and that Turbo C++ is about the fastest (C) compiler around, although it is not as fast as Turbo C V2.0.

There are two gains to be had from waiting longer for your object code to be delivered: thoroughness of language parsing and quality of object code. The compiler is now better at picking up obscure errors than it used to be. For example, I ran TC++ over a version of the Tetris game that I wrote for Turbo C V2.0. It spat out an error where I was trying to write to a dereferenced pointer to a structure. On closer investigation, it turned out that I had declared a pointer to a constant structure, instead of a constant pointer to a structure (stop snig-

## Plum Hall C Benchmarks

(Scaled relative to slowest result)

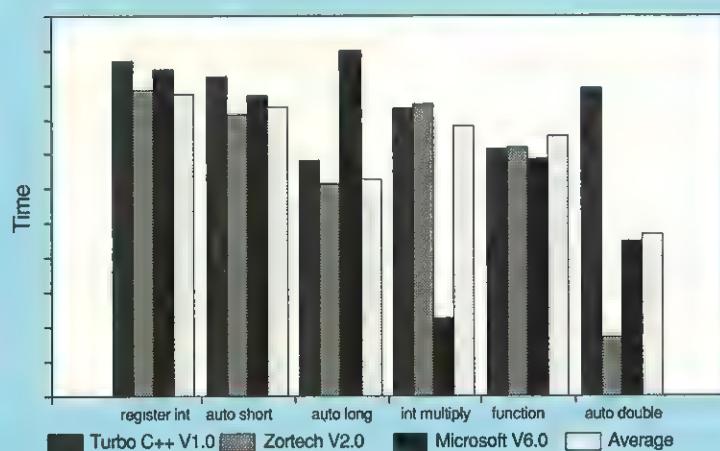


Figure 2 - Graph of Plum Hall C Benchmarks

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gering, it could easily happen to you), but that Turbo C V2.0 had happily allowed me to go ahead and walk all over my supposedly protected data. In this case it did not matter, but you can easily imagine a situation where a safety feature like this would be a life saver.

This tighter checking of the source follows from the requirements of C++, which is less tolerant of monkeying around with types than its parent language, and the requirement of ANSI conformance. This has come a long way since Turbo C V2.0, which failed 16 out of 79 tests in the famous Plum Hall ANSI conformance test suite (described by the BSI's Neil Martin in PCW April '89). Turbo C++ scores 73 by itself and, if you pass the test code through a supplied utility called TRIGRAPH.EXE, it scores 78. (Borland takes the view, correctly in my opinion, that trigraph sequences, such as ??= for #, are so rarely used, there is no point in wasting the time of the ordinary punter by processing them in the main compiler itself. Apparently, omitting the ability to cope with trigraph sequences speeds things up significantly.) The failure is in the test to cope with multi-character *character* constants, such as '1 2 3 4'. This places Turbo C++ up there with the ANSIest of compilers, the others being JPI TopSpeed C V1.0, Lattice C V6.0, Microsoft V6.0 and Watcom V7.0.

Borland also claims to provide a full implementation of AT&T's C++ V2.0 specification - ie the version that demands multiple inheritance and pointers to members (the latter is missing from Zortech V2.0). The company says that it will track new releases, such as the recent V2.1 (which is not much different from V2.0) and the forthcoming ANSI version. Obsolete features, such as the keyword overload, which was previously required when overloading function declarations, can be used, and generate a suitable warning message. But it is over another V2.0 feature, type-safe linkage, that I have a quarrel with Borland's design.

## Mangled

AT&T's standard requires that inter-module linkages to functions take account of the function's signature as well as its name. In other words, under C++ you must not be able to refer to a function defined in one module by different prototype (with the same function name) supplied in another. This type-safe linkage is achieved by inventing a new name for the function, based on the type and number of its arguments plus, if it is a method, its class. The Specification says nothing about how this mangling should be achieved. However, there is a bundle of papers that are distributed with the specification as 'Selected Readings'.

One paper, by Bjarne Stroustrup himself, is called *Type-safe linkage for C++*, and it includes an algorithm for this mangling. This is the algorithm used by AT&T's front compiler (and hence by Glockenspiel's compiler), and adopted by Zortech for its compiler. Borland, on the other hand, uses a little something of its own. Given the method

```
int obj1::fn1(int i, int j)
Zortech produces _fn1_4obj1Nii,
Borland puts out @obj1@fn1$qii.
```

The problem, of course, is that a class library compiled for use with Borland's compiler won't work with anybody else's, and vice versa. Did Borland choose to make its product incompatible for marketing reasons, or out of incompetence, because the development team didn't spot Stroustrup's paper until too late?

A glance through the results of the various tests that I have done (which, although unrepresentative, unrealistic etc, confirm my subjective observations) will show you that, as an optimising compiler, Turbo C++ is nothing to write home about. The timings, incidentally, were made with the command line version of the compiler (oh, did I not tell you there was a separate command line version? Well there is, along with a linker, a librarian and a conventional MAKE utility). It has noticeably improved from the previous release - it seems to make better use of registers than Turbo C V2.0 - but it is not up there in the ozone with the Watcoms of this world. However, as Adam Denning noted last month in his review of Microsoft C V6.0, a man who buys a compiler on good performance alone is a fool. There again, a man whose code runs faster may sell a few more copies of his package...

## Libs and Docs

Turbo C++'s libraries are very similar to those of its predecessor. There are still the dear old BGI routines for handling graphics. The exotic ANSI functions prototyped in LOCALE.H have been added. There are a few classes: complex numbers, supported by overloaded trigonometric functions, BCD, a set of generic data structures, such as lists and queues (these are all derived from a single object type, Smalltalk style, and are documented only on disk, for some reason) and I/O streams, old and new (V2.0) style.

The inclusion of new-style streams is one over Zortech's effort, which only offers the old sort. Whether this matters to you depends on whether you belong to the 'cout is brill, it's just like Pascal's write, you can forget about types' camp, or the

```
;Turbo C V2.0
;Time per iteration in ms= 40.94

_sieve proc near
    push bp
    mov bp,sp
    sub sp,8196
    push si
    push di
    xor di,di
    jmp short @5
@4:   mov byte ptr [bp+di-8192],1
    inc di
@5:   cmp di,8190
    jle @4
    mov word ptr [bp-8194],0
    xor di,di
    jmp short @9
@8:   cmp byte ptr [bp+di-8192],0
    je @7
    mov ax,di
    add ax,di
    add ax,3
    mov word ptr [bp-8196],ax
    mov si,di
    add si,ax
    jmp short @11
@13:  mov byte ptr [bp+si-8192],0
    si,word ptr [bp-8196]
@11:  cmp si,8190
    jle @13
    mov ax,word ptr [bp-8194]
    inc ax
    mov word ptr [bp-8194],ax
@7:   inc di
@9:   cmp di,8190
    jle @8
    mov ax,word ptr [bp-8194]
    pop di
    pop si
    leave
    ret
_sieve endp
```

```
;Turbo C++ V1.0
;Time per iteration in ms= 36.63

_sieve proc near
    push bp
    mov bp,sp
    sub sp,8192
    push si
    push di
    xor di,di
    jmp short @1098
@1050: mov byte ptr [bp+di-8192],1
    inc di
@1098: cmp di,8190
    jle short @1050
    xor bx,bx
    xor di,di
    jmp short @10290
@10146: cmp byte ptr [bp+di-8192],0
    je short @10266
    mov ax,di
    add ax,di
    add ax,3
    mov dx,ax
    mov ax,di
    add ax,dx
    mov si,ax
    jmp short @10218
@10194: mov byte ptr [bp+si-8192],0
    si,dx
@10218: cmp si,8190
    jle short @10194
    mov ax,bx
    inc ax
    mov bx,ax
@10266: inc di
@10290: cmp di,8190
    jle short @10146
    mov ax,bx
    pop di
    pop si
    leave
    ret
_sieve endp
```

Figure 3 - Object code for Sieve function

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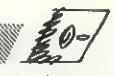
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## Not Entirely Unbiased

*Steve Teale is a man who knows all about MS-DOS C++ compilers: he writes Zortech's class libraries. In an impish mood, we asked him what he thought of Turbo C++.*

A couple of months ago, my association with Zortech being known, I jokingly asked Will Watts whether he would like me to do a partisan mini-review of the Borland C++ compiler when it came out. That will teach me!

In the event, the Borland release date left a tight publication deadline, so I scratched my head to think of some code which would tax the two compilers, and decided to try first an implementation of extended two's complement integer arithmetic, with overloaded operators, lots of implicit constructor calls etc.

It's an interesting property of different compilers that, given the same code, they will produce different sets of error messages. If code has been developed with one compiler, another will generally throw a different light on it. Needless to say my own code was not immune in that respect. This fact of life doesn't favour a compiler with an existing body of code, compared to a new compiler with hardly any code to its name, but any critics should remember that in the longer term such traffic is two way!

The appearance of a C++ compiler from one of the bigger guns of the DOS world might give cause for thought to C programmers who, until now, have got by thinking that C++ is just a gimmick. Maybe it is time to try. But if you want to develop programs for Windows 3 and Presentation Manager, then the Borland release will be a non-starter for you, since it doesn't handle these at all.

Another choice you will have to make is over the split which seems to have developed in the C++ world. On one hand there is what might be called the AT&T camp. C++ is AT&T's baby, and they have consistently emphasised C++ as a better C, a general purpose programming language with facilities for object-oriented programming. On the other hand are the pure OOP devotees, who really wish that C++ was Smalltalk.

A look at the class libraries provided as part of the Borland C++ package seems to indicate that Borland belong in the latter camp. If your view is 'and so they should', I suggest you take in the 'Silver Bullet' article by Niklaus Wirth in .EXE Magazine, May 1990. This piece takes a long, cool look at some object-oriented excesses. In saying this, I am not putting down OOP. It is great in its place, but silver bullets are scarce. Zortech has tended to adopt a more conservative approach.

Enough, back to my ISOLATED test. The program does a million different long multiplications and divisions. Both compilers produced the same result, but with interesting performance differences, as you can see in Figure 1.

This was not a contrived example, but a piece of production code which I chose because it was almost library independent, and not I/O bound. Borland clearly have some way to go, and Zortech is not a stationary target!

	(straight compile)			(compile for speed)	
	Compile time	run time	.EXE size	run time	.EXE size
Borland	6.10	748	29658	755	29722
Zortech	5.54	403	25116	385	24556

*Steve Teale develops C++ class libraries up in Harrogate, where he finds time to work on his own consultancy, Microcosm Computing (0423 562055).*

*The code that Steve used for his test forms part of Zortech's forthcoming C++ Tools, so he is unable to place it in the general public domain. However, he has made it available to us, so we can verify that there was no monkey business! It is our intention to invite a Borland representative to write a 'return match' article when the new Zortech compiler, due for release in early July, becomes available.*

'print f () may be old-fashioned, but at least you can see what it is doing' camp. The function documentation is bountiful, included both on disk and paper, and has been expanded. For example, the description of the DOS Keep () routine includes the listing of a small TSR program which hooks into the clock interrupt.

Other documentation also maintains the traditional, high Borland standard: there is no attempt here to fob you off with a quick reference card and some hypertext help files. There are four fair-sized perfect-bound manuals, entitled *Getting Started* (which includes C and C++ language tutorials), *User's Guide*, *Programmer's Guide* (contains ANSI mandatory implementation-specific features list) and *Reference Guide*. One complaint. There is no explanation of the name-mangling algorithm, not even in the mixed language programming section.

## Conclusion

Borland is one of the big boys in the MS-DOS compiler world; the fact that it has a C++ compiler is significant, because it improves the chances of C++ gaining general acceptance. This, however, is a marketing observation. In .EXE, we like to retain a technical bias. Technically speaking, Turbo C++ is a bit disappointing.

TC++'s output code is lacklustre; its selection of class libraries, albeit inclusive of AT&T's V2.0 stream I/O, is not large. TC++ is binary incompatible with libraries for Zortech, and probably any other PC compiler that happens to come along. There is no support for Windows (although this is promised within a few months) or OS/2 (this is just promised). Plus points: there is a good system of overlays, the integrated environment is certainly cute, you can use Turbo Debugger on the programs that you produce.

During my career as a programmer, none of the software tools that I used were as slick or as neat as Borland's: this is how I became a fan. Turbo C++ seems to lack the special sparkle of the earlier efforts; it is steady rather than brilliant. I hope that they remember to put back the sparkle for next time.

EXE

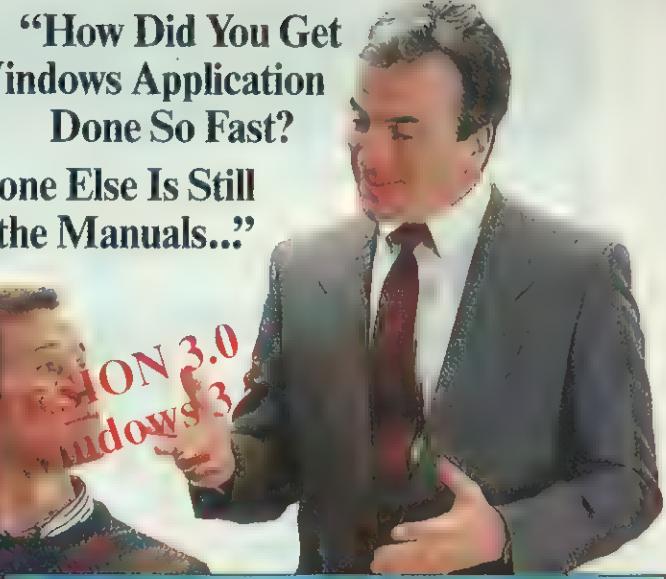
Turbo C++ V1.0 retails at £149.95, Turbo C++ Professional (with extra programmer's tools) costs £249.95. The software is available from dealers. There are special deals available for registered Borland users (not just Turbo C) - the company will contact them soon with details.

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----------------	-------	--------	-------------	--------	------	------

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  - Bourne Shell
  - Visual Shell
  - Shutdown
  - Startup
  - Install Applic
  - Remove Applic
  - Display Process
  - Display TTY
  - Modify TTY
- Db Options
  - Sys-IX
  - System-IX
  - Guru
  - Csh-IX

**File Options**

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- Maintenance
- Create Dir
- Remove Dir
- List Dir
- Print Dir
- Create File
- Remove File
- Print File

**Backup**

- Back Options
  - Backup Files
  - Backup Filesystem
  - List Backup
  - Print Backup
  - Restore Files
  - Format Diskette
  - Copy Diskette

**Maintenance**

- Mnt Options
  - User
  - Printer
- Invoice Letters

**System**

- Print Options
  - Add Printer
  - Remove Printer
  - Enable Printer
  - Disable Printer
  - Start Schedule
  - Stop Schedule
  - Lp Status
  - Print File
  - Set Default Lp
- User Options
  - Create User
  - Remove User
  - Create Group
  - Remove Group
  - Change Password
  - Applications

**Acct**

- Acct Options
  - Account User
  - Account Group
  - Account TTY
  - Account All
  - Enable Account
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**Mail**

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  - Send Mail
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# Program Structures of the Fourth Kind

*The search for structure in computer programs, especially structure avoiding the use of GO TO, has been going on for over 20 years. Richard Pickard offers a critique of the options in different programming languages, and suggests an alternative.*

During the 1950s and 1960s, the 'bad old days', a succession of procedural programming languages was developed, each at a 'higher level' than its predecessor. For most of this period, the bulk of the design effort was aimed at making it easier and faster to write programs. There was little to improve the quality of code: the new high-level programs didn't work in just the same way that the old assembler and machine-

code programs didn't work. Because the compiler writers' thinking remained heavily oriented towards the machine and its features, high-level languages commonly offered only a limited range of data types and simplistic control structures.

From the machine's perspective, 'data processing' was mainly about 'processing'. 'Processing' meant doing calculations,

moves and tests; and looping, branching and calling subroutines. 'Data' was in the province of the application - nothing to do with the tool being used - and compilers did little or nothing to check the legitimacy of what operations on data were being attempted. Certainly, the languages of that era provided a variety of data types for the convenience of the programmer, but these types were predefined - even in COBOL - and only rarely were there any strong rules about the ways in which they could be combined.

However, it is structure issues that concern us here. The main point about structure - as it was first offered in high-level languages - was that it was barely recognised to exist. The original IF statement in FORTRAN was merely a three-way conditional branch; COBOL did a little better with the 'conditional sentence'; not until ALGOL did we have a clear and usable way of nesting IFs. The situation was a lot better with loops; these, by definition, have a clear scope. (The scope is specially clear if, as in COBOL, the loop body is out of line and referred to by its label.) All early languages provided procedure calls and returns - most of them allowed a return to the calling procedure from any point in the body of the called procedure.

## Going, going, gone

The weakest area was probably that of interrupt and error handling. It was hard to find a high-level language providing direct control over hardware interrupts and software events with equal power. The handling of hardware was (and is) not an integral part of most so-called system programming languages - it was provided by libraries of assembler routines. Language support for the handling of unpredictable software events was similarly missing.

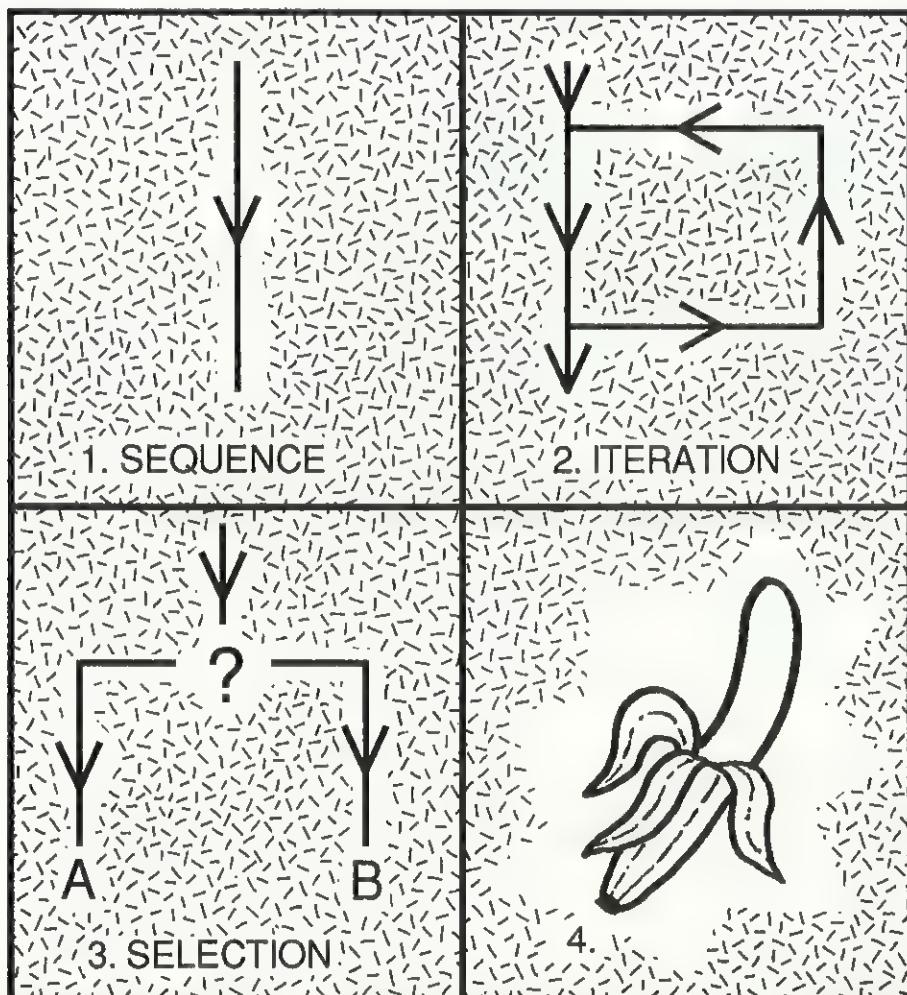


Figure 4 - The same solution expressed with the POSIT

```

...
POSIT NoFatais:
  POSIT FileWillEnd:
    LOOP
      MyReadNext (ProdFile, ProdRec,
        FileWillEnd, NoFatais.BadFileStatus) ;
      WrLn ; WrCard (ProdRec.ProdCode, 7) ;
      WrStr (ProdRec.ProdDesc) ;
      POSIT LookUpWillBeOK
        WrStr (SupplierName [
          MyLookUp (Supplier, ProdRec.SuppCode,
            LookUpWillBeOK.NotFound) ;
        ]) ;
      DENIAL NotFound:
        WrStr ("Supplier name not found for code: ") ;
        WrCard (ProdRec.SuppCode, 0) ;
      END LookUpWillBeOK ;
    REPEAT ;
  END FileWillEnd;
  WrLn ; WrLn ; WrStr ("End of list") ;
  Close (ProdFile) ;
DENIAL BadFileStatus:
  WrLn ; WrLn ; WrStr ("Product file error: ") ;
  WrCard (ProdFile.FileStatus, 0) ;
END NoFatais ;
...

```

Does any language which you know allow this kind of control? The only thing near it which I have seen is the Action Diagram, in KnowledgeWare's Analyst

Workbench. This is a picture-and-text editor for the specification of structured procedures. It allows the drawing of Sequence, IF and WHILE blocks and

it allows the drawing of an EXIT from any block to any outer level. Because the mouse is used to point to the outer level, no labels are involved (in a text-only language such a handle cannot be avoided). KnowledgeWare's EXIT is equivalent to the PROVE of the POSIT.

I would like the question of how to replace the GO TO reopened. The generality of the loop structure has been successfully implemented in the PLANC language (*The Third Side*, .EXE November '89) and should be copied by others. In the same way, we need a generalised block-and-escape structure, such as I have described here.

EXE

*Dr Richard H Pickard has been a full-time data processing practitioner and writer on the subject since 1964. He is equally interested in the application of DP techniques to business problems as in the techniques themselves. He is now a senior computing specialist for Whittbread. Richard may be contacted on 0525-61836.*



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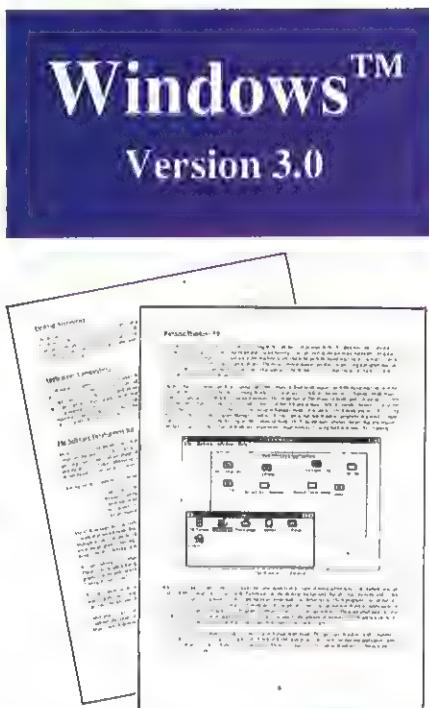
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a BREAK with an optional number - to specify how many levels of block from which to escape.

Pascal is the most famous language to be designed specifically for structured programming; curiously, it retains the GO TO and fails to provide a BREAK or a RETURN - each block of code is entered at its beginnings and exited at its end. As Kernighan pointed out (and anyone who's tried it knows) this combination makes for some tricky coding, especially in loops.

## The Problem

Now it's time to ask 'what is the real problem?'. We must certainly agree that the writing of easily understood programs in self-contained sections is desirable. It promotes easier debugging and bug pre-empting walk-throughs. It may lead to easier proofs of correctness. These factors taken together raise quality and simplify the task of managing software production and predicting costs.

The problem is that, when we write real programs, it is nearly always the case that we have to cater for errors and exceptions whose occurrence, by definition, must radi-

cally change the course of a program. Consider the simple problem of reading lines of

10 years on) and Ada (20 years) have also implemented similar handlers.

## Testing a flag means that you missed the chance to act when the event occurred

text until end of file. In old-fashioned programming, the end-of-file case would have been handled by a (smelly but effective) GO TO. Some of the 'commercial' programming languages offered escape techniques. PL/1 (circa 1965) provided the ON statement to specify action to be taken if certain software or hardware conditions arose; these conditions included both arithmetic and programmer-defined exceptions. COBOL provides the DECLARATIVES sections to trap file- and record-handling exceptions and errors. Some of the newer versions of C (circa

But the notion that a block of code could have a natural escape route was not general. The exception-handlers of PL/1 and COBOL were always written before (ie textually above) the points in the program where their conditions could arise; to implement a change of course in the main body of the program, these handlers had to end with a GO TO, or set a variable (flag) to be tested by the main body when it was resumed. There still wasn't a way to express a programming idea such as *Read the next text-line, but if at end of file, get on with the closing sequence (and then the rest of the program)* except to express it with an explicit or implicit GO TO. (I mention the implicit GO TO because of the example provided by the FORTRAN READ statement's optional clause: END=label.) Notice that COBOL's AT END clause doesn't get us out of any holes either.

Escapes are what GO TOs are properly used for. They lead to a program section which deals with some situation which is:

- Radically different from what the program is doing at the point from which the escape is made.
- Common to different points in the program (but not necessarily).

'Now', you may say, 'this is an obvious case for invoking a procedure.' Not so. You only shift the problem to what to do when the procedure returns, just like the ON in PL/1 or the DECLARATIVE in COBOL. This is definitely a job for GO TO.

An area of program construction which has worried me for a long time (as a result of avoiding GO TOs) is the *Why am I here, and where do I go next?* problem. On exit from a loop (never mind how), such as that contained in a table lookup, do we have a valid result? When a READ fails, and the cause has to be unravelled, what has to happen for the different cases of 'No record found', 'File not opened', 'Abort', 'Retry' and 'Fail'?

One technique for handling this problem is to invent an auxiliary variable (flag), whose value is set inside the block doing the work, which is tested on exit from the block. IF or CASE constructs can be used for the test, and the flag has no other use in the program other than this steering function. Sometimes we cheat, and use the result obtained by the inner block in two ways. For example, in the case of a table lookup, the result can be given an 'impossible' value to indicate the failure of the search. Note that this problem and its solution are the same if the attempted

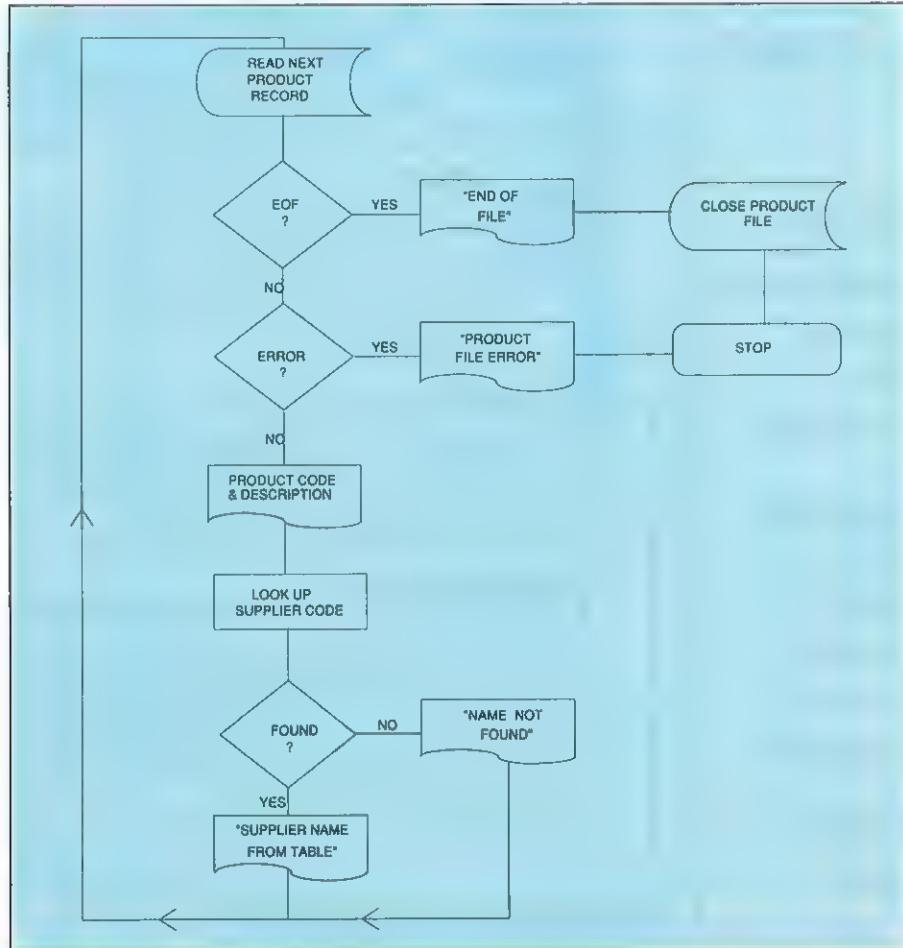


Figure 2 - The sample problem as a flow chart

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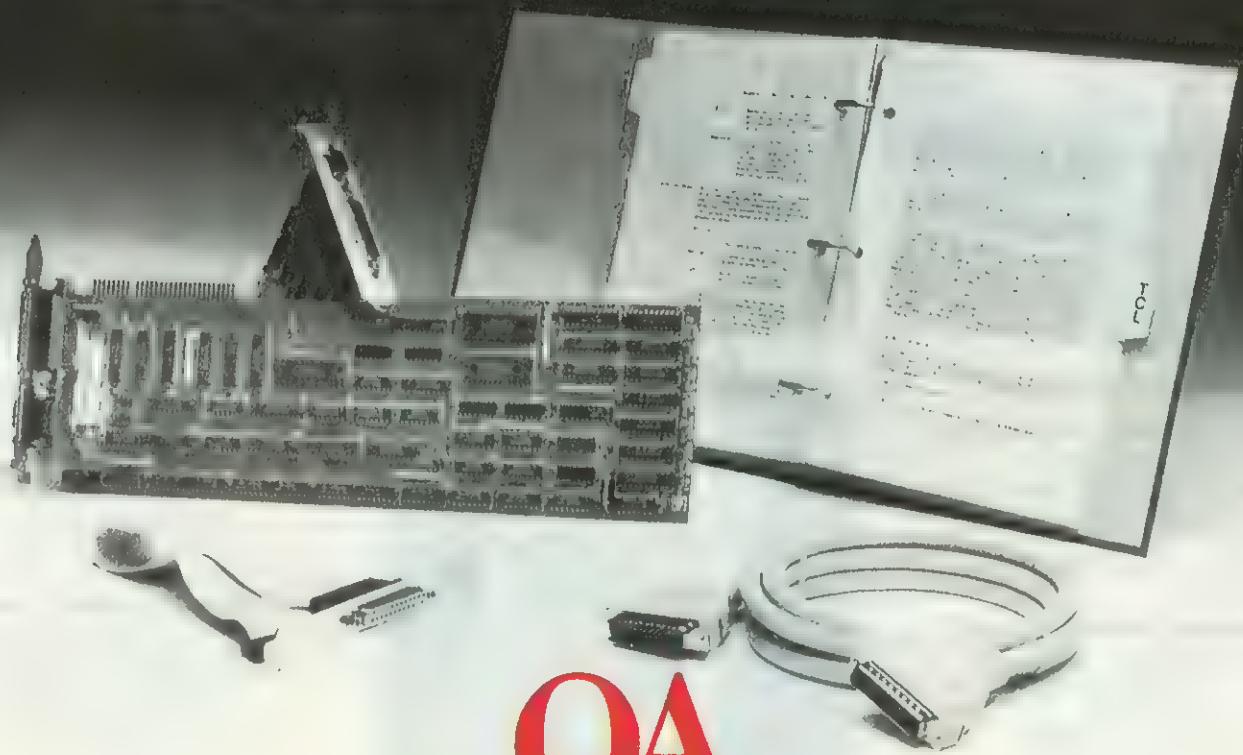
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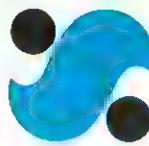
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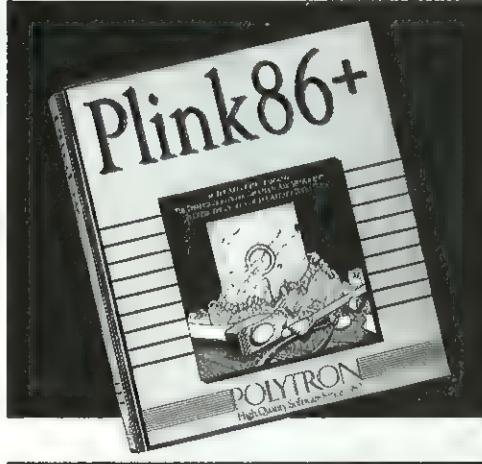
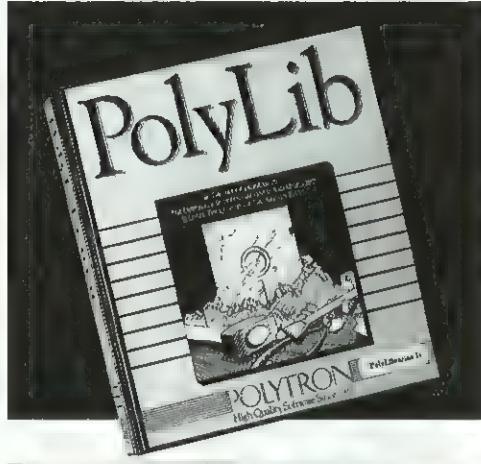
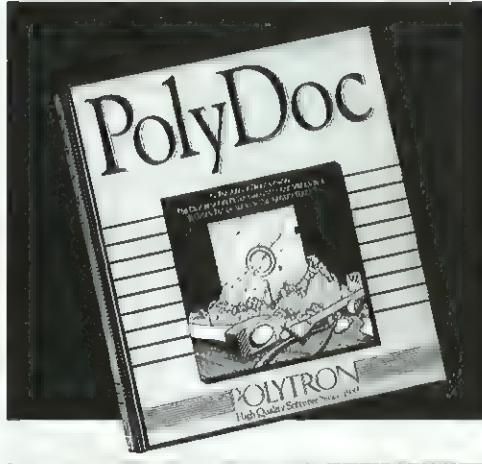
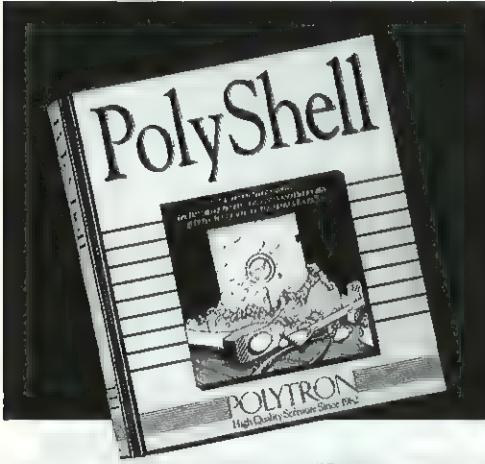
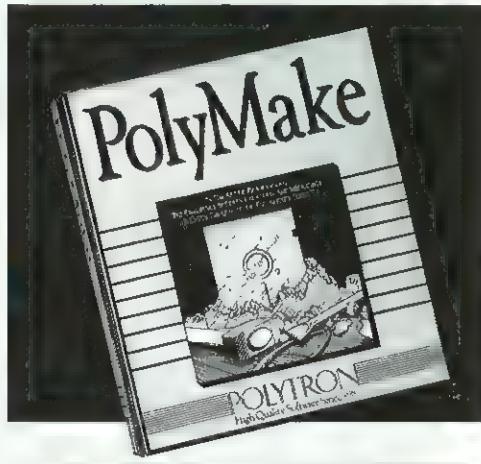
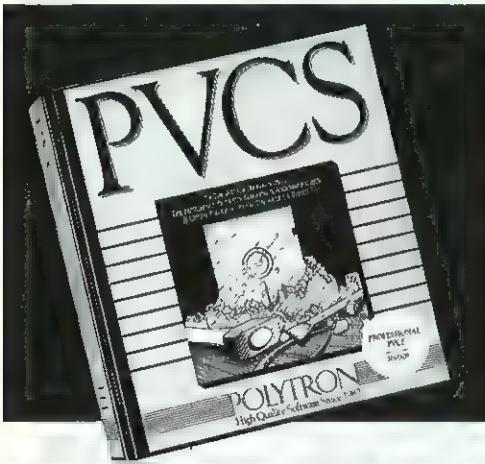
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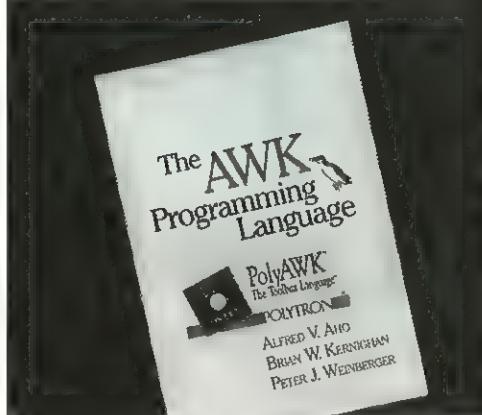


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work is done by in-line code or by a separate procedure.

When procedures are indeed written separately, they can be constructed as functions, and substituted in the places where an auxiliary variable might have been used. This saves the program itself having to declare the variable, but it will probably still exist, hidden inside the function's definition.

## The Solution

I would like to reduce programs to their essentials. If a section of code can have different successor sections, depending on the conditions encountered during the execution of that section, then - right at the point where the condition is identified - I would like to arrange to execute the relevant successor. If a variable must be created just to convey the significance of some earlier result, and will only be used once, to determine the next action then I don't want it. Having to test a flag means that you missed the chance to act when the event occurred.

We are looking for a control structure which satisfies the following requirements:

- To escape from the current block to some later block.
- To escape up through any number of levels.
- To arrive at the destination with some idea of why the escape was made.
- To retain a block structure in which uncontrolled branches cannot be made (accidentally or deliberately).

The solution - which is not wholly my own, and has its roots in academic work done in 1970 - is to use a new kind of

## *When they threw out the GO TO, maybe they were too quick to throw out the label*

block and a restricted form of GO TO. This new block - the fourth kind - is called a POSIT ('let it be supposed'). As you can see from Figure 1, it has a main body and any number of conditional parts. The POSIT and the conditional parts are all given names. Normal program flow is from the beginning to the end of the main body and then to the next block at the same level, ie after the last conditional part. Abnormal flow is initially from the beginning of the main body and - at some point where an exception is detected - to just one of the conditional parts and then on to the next block. The way of making escape is with a PROVE statement, which nominates the POSIT, or with a DENY statement, which nominates the POSIT plus a conditional part. PROVE makes a

complete escape, directly to the next block, DENY makes the escape via the named conditional part.

The scope of the names in a POSIT is statically limited to its body; escapes to irrelevant, external conditional actions are, therefore, impossible. The names of POSITs or their conditional parts may be passed as actual parameters to procedures so that they may PROVE or DENY on behalf of their callers. (The formal parameter would be of type POSIT or DENIAL.)

## Does it work?

Figures 2-4 show a simple program. As a flowchart, the problem is easily understood; it's to about listing Products, from a file, and their Suppliers. Suppliers are few enough that they can be looked up in a table. The programmed versions are done in Figure 3 with GO TOs and in Figure 4 with POSITs to show how easy they are to use (if you relax and concentrate).

Let's check how well some of the problems and requirements have been answered:

- POSIT allows escapes from the current block to some later block, up through any number of levels.
- The place to which escape is made - the destination - is chosen according to the cause.
- Branches cannot be made, except to points in, or at the ends of, surrounding blocks.
- There is no need for flags.
- Called procedures can cause an escape; thus hardware-related interrupt handlers can act to change the course of a program.

It looks good so far, the pragmatic requirements of real code have been satisfied, and the dangers of GO TOs avoided. Maybe, when they threw out the GO TO, they were a little too quick to throw out the label.

Two more areas to check are recursion and multi-tasking. Recursion is not really a problem, because the executions of the called procedures (self or other) are synchronous. But suppose that the main body of a POSIT has initiated some asynchronous tasks and - while doing some work of its own - PROVEs or DENYs itself. What should happen to the still-working tasks? My answer is that the operating system should terminate them, preferably by a DENY of their outermost POSIT, and they are forgotten about (but I'm prepared to discuss it).

```

...
LOOP
  ReadNext (ProdFile, ProdRec)
  IF ProdFile.FileStatus = EOF THEN
    WrLn ; WrLn ; WrStr ("End of list") ;
    GO TO EndFile
  END ;
  IF ProdFile.FileStatus <> OK THEN
    WrLn ; WrLn ; WrStr ("Product file error: ") ;
    WrCard (ProdFile.FileStatus, 0) ;
    GO TO Windup
  END ;
  WrLn ; WrCard (ProdRec.ProdCode, 7) ;
  WrStr (ProdRec.ProdDesc) ;
  i := LookUp (Supplier, ProdRec.SuppCode) ;
  IF i > 0 THEN
    WrStr (SupplierName [i]) ;
  ELSE
    WrStr ("Supplier name not found for code: ") ;
    WrCard (ProdRec.SuppCode, 0) ;
  END ;
  REPEAT ;

EndFile:
  Close (ProdFile) ;
WindUp:
...

```

Figure 3 - The problem solved with GO TOs



Computer scientists had long explored styles of programming including functional (eg LISP), assertional (eg ancient RPG and modern PROLOG), a massive variety of procedural and special purpose languages and, more recently, neural and vegetable approaches. But in the mid 1960s attention was focused on procedural languages (quite properly so, because most programmers were using them). In this period - and ever since - the academics have searched for purer structures; their constant

bugbear has been the GO TO. In 1966, Böhm and Jacopini introduced an algebra for programming based on the idea of nested blocks of code, in which each block had one entry point and one exit. It used only the structures Sequence, IF and WHILE. These authors admitted that not all programs could be expressed in their algebra. In 1968, Edsger Dijkstra's famous letter 'GO TO Statement Considered Harmful' stirred up much ardour in the hearts of purists and soon it was proved, by others,

that 'every flowchart program can be written without GO TO statements by using WHILE statements'.

High-flown academic debate was all very well, but it took a second school of thought in favour of leap-free code to popularise the notion 'on the ground'. There was a growing band of program provers (such as Floyd in the early '70s), who had a need to limit the damage to their methods that a wayward GO TO could inflict. It was clear that well-structured programs were much easier to understand. The GO TO-less view was promoted and taken up by the makers of increasingly large and complex software systems.

In general, languages continued to provide a GO TO, but there began to appear some varieties which left it out. In these languages, other techniques were introduced to replace it. The most common, in one form or another, was 'BREAK' or 'EXIT'. BREAK caused a transfer of control from within one block to the beginning of the next block at the same level; mostly it was used to provide a premature escape from a loop. One variation which I have seen had

```

POSIT <label> :
    --- labelled block

    [<sequence>
     PROVE <label> | DENY <label>. <c-label> ]
     <sequence> ...] --- main body with
                           different kinds
                           of escape

    [DENIAL <c-label> :
     <sequence> ] ... --- any number of
                           conditional parts

    END POSIT <label> --- labelled end

(Square brackets show optional sections; vertical bar shows alternatives; ellipses (...) show sections which may be repeated.)

```

Figure 1 - A POSIT block in outline

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# OS/2 Dynamic Link Libraries

*Dynamic linking is a concept familiar to Windows programmers; but you have to meet them under OS/2 to see them at their best, says Graeme Burton.*

The concept of Dynamic Link Libraries (DLLs) is fundamental to OS/2: the operating system kernel itself is packaged as a series of DLLs. However, the documentation supplied with the various toolkits and compilers is hard to assimilate, and spread widely around the manuals. The official texts are also short on practical advice. There are no indications of where problems are likely to occur, or how to solve them.

In this article, I shall explain the concepts behind DLLs, and how to build and debug

```
/*
 * This is the main program for the
 */
/* triangle application. It accepts the
 */
/* arguments from the command line.
*/
/*
 *include <stlib.h>
 *include <stdio.h>
 */
/* Forward-declare
   the triangle function */
int pascal far
    triang ( double, double, double );

int main(argc, argv, envp)
int argc;
char *argv[];
char *envp;
/* Sides of triangle
   read from command line */
double a,b,c;

/* Check the arg count is correct
   - quit if it isn't */
if (argc < 4) {
    printf ("Usage: TRIANG a b c\n"
           "where a, b, c are the sides"
           "of the triangle\n");
    return (-1);
} /* endif */

/* Unpack the arguments */
a = atof(argv[1]);
b = atof(argv[2]);
c = atof(argv[3]);

/* Call the triangle procedure
   and print the results */
switch (triang(a, b, c)) {
case 0:
    printf ("Equilateral triangle\n");
    break;
case 1:
    printf ("Isosceles triangle\n");
    break;
case 2:
    printf ("Scalene triangle\n");
    break;
default:
    printf ("Impossible triangle\n");
    break;
} /* endswitch */

/* Return to OS/2 */

```

Figure 1 - EXE source for the TRIANGLE program

programs which incorporate DLLs. I will also discuss some common problems and their solutions. Although I am mainly aiming at C programmers using either the IBM C/2 compiler V1.1 or the Microsoft C compiler V5.1, this does not preclude the use of other languages or compilers - DLLs can be written in any language. However, these are the recommended tools for building OS/2 applications.

## Concepts

Under the MS-DOS operating system, relocatability of the various system services is achieved by using software interrupts. Shared code, such as the C runtime libraries, are combined with the application at link time to form part of the .EXE or .COM program file. OS/2 provides a mechanism for applications to resolve references *after* linking has been performed, thus achieving run time relocatability. This is the Dynamic Link Library, or DLL.

DLLs are stored in conventional OS/2 binary files with the extension '.DLL'. When a function contained in a DLL is required, the file is loaded into memory by the loader task, in much the same way as a .EXE file is loaded. Thus, if a program uses a DLL, the executable image is now split into two files: the .EXE file and the DLL file. The functions contained in a DLL are shared between processes by means of the Global and Local Descriptor Tables; the GDT and LDT. This means that only one copy of the code is required.

To see what goes on, let's examine the C function `printf()`. If 15 programs use this function, each one has its own copy of it in the executable file. This is not too serious in terms of disk space requirements. However, when we move from the single tasking MS-DOS environment to the multi-tasking OS/2 environment, and all 15 copies of the program are running at the same time, the `printf()` function will consume 15 times as much RAM,

which is definitely bad news. The cure is to place this function in a DLL. Only one copy of the code is loaded into memory, and all tasks share this copy. Further benefits occur when updating packages and code libraries. If code is packaged in the form of DLLs, upgrades can be supplied to customers by providing a refresh of the DLLs. No refresh of the main executable module is required.

A DLL may be loaded into memory in two ways. The first is to define the procedure required from the DLL when linking your program, either by means of an import library or in a definitions file. The operating system will then load the DLL (if it isn't already in memory) when the .EXE is loaded. The second method is to load the DLL into memory under program control, by using the OS/2 system function `DosLoadModule()`, and locate the entry points required from the DLL with the `DosGetProcAddr()` function. Using this method, a DLL can be removed from memory when it is no longer required (and thus free the RAM it used) by making a call to the `DosFreeModule()` function. OS/2 maintains a usage count of DLLs: when a process links to a DLL, either implicitly or via `DosLoadModule()`, the usage count is incremented. When the link is broken, the usage count is decremented. When the usage count goes to 0, the DLL is unloaded from memory.

The DLL implementation provided by OS/2 forces certain constraints upon users. The internal segment register assumptions made by the compiler in the various memory models (Large, Medium etc) no longer apply. With a non-DLL program, the DS and SS registers are assumed to be the same: with a DLL, this is not the case. This is because the library procedure uses its own data segment, set by the loader when the DLL is brought into memory, and uses the calling procedure's stack segment. As a result, a short prologue has to be included at every routine's entry

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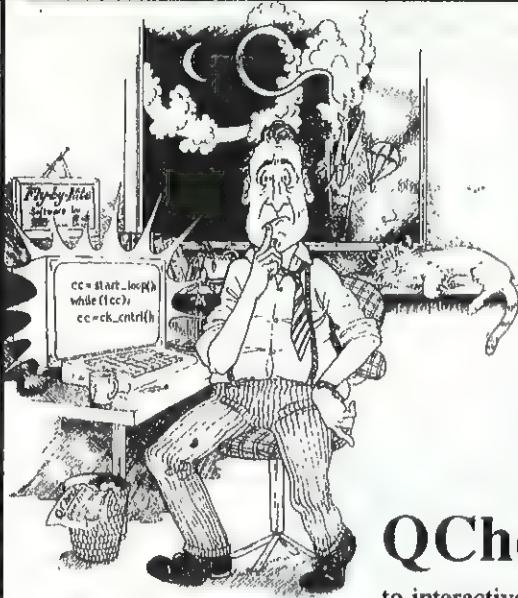
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*Figure 2 - DLL source for the TRIANGLE program*

```
/*
 * This function calculates what sort
 * of a triangle has been. It returns
 * 0 for an equilateral triangle,
 * 1 for an isosceles triangle,
 * 2 for a scalene triangle,
 * 3 for an impossible triangle.
 */
int pascal far triang ( a, b, c )
/* Input sides of the triangle */
double a,b,c;
{
    /* Check for impossible triangle */
    if ((a <= (b + c)) &&
        (b <= (a + c)) &&
        (c <= (b + a))) {
        /* Check for equilateral triangle */
        if ((a == b) && (a == c)) {
            return ( 0 );
        } else {
            /* Check for isosceles triangle */
            if ((a == b) || (a == c) ||
                (b == c)) {
                return ( 1 );
            } else {
                return ( 2 );
            } /* endif */
        } /* endif */
    } else
        return ( 3 );
}
```

point to save the current DS and replace it with the DLL's. The calling procedure's DS is restored at function exit by a similar mechanism. There are several ways to force the inclusion of this code. The recommended method is to compile with the /Alfu memory model. An alternative approach, which allows function by function control at source code level, is to declare functions with the \_LOADDS (= LOAD DS) keyword.

When a DLL is created, you have choices to make about both initialisation and data sharing. A user supplied initialisation procedure can be called when the DLL is loaded, although this requires an assembler stub. Instructions supplied through a definitions file at the link step can force this procedure to be called when the DLL is first loaded into memory, or each time a new module links to the DLL. The data used by the DLL can be global, ie shared between all processes that are using the DLL, or local, in which case each instance has a different data segment. Again, instructions in the definitions file control the data sharing.

As well as functions, data can be stored in a DLL. A variable to be exported must be specified in the definitions file, with its name preceded by '\_'. DLLs can also be used to contain PM resources: if the resource is stored in a DLL, the module handle of the DLL is passed to the PM calls WinLoadDlg(), WinLoadAccelTable(), WinLoadMenu(), WinLoadMessage(), WinLoadPointer() and WinLoadString(). The module

handle for a DLL can be obtained by calling either of the OS/2 functions DosLoadModule() or DosGetModuleHandle().

## Library Functions

The DLL developer cannot use the standard C run-time library functions. These were not written for use with DLLs; any attempt to link them to a DLL produces an unresolved external main. It is possible to use the standard run time libraries by kludging assembler links, but it is far easier and more sensible to use the libraries specially provided for this purpose: the LLIBCDLL and CRTLlib libraries.

The LLIBCDLL library is linked statically with the DLL, and contains all the C functions provided by the standard C library. It is intended to be used with the large memory model. The functions within this library are not re-entrant (for example, the fcvt() function, which converts a floating-point number to a character string, uses a static buffer), and so multi-threaded code linked with this library will not work. You should note that DLLs which use LLIBCDLL cannot be freed by calling DosFreeModule(). This is because the start-up library code installs an entry in the process's exit list. Once these DLLs are loaded, they stay loaded until the invoking process is terminated.

DLLs which are linked with the LLIBCDLL library must be compiled with the /FPA switch, specifying the alternate math(s) library, if they use floating point operations, otherwise the C library floating point functions will not work. This is because the called function (in the DLL) does not know what state the calling application has left the 80x87 processor in - and so cannot use it.

The second library is the CRTLlib (C Run-Time Library), which consists of a package from all the C libraries, bundled into a DLL. This library is re-entrant, and allows floating point processor instructions to be used. The CRTLlib DLL can be linked to produce either .EXE or DLL modules. To create a DLL module, you simply define the symbol DLL to the compiler (using the #define command in the source code). You must

include the special multi-threaded versions of the header files when you are going to use the CRTLlib library (generally stored in the INCLUDE\MT subdirectory). This is because the C library function declarations are slightly different for the re-entrant libraries.

You must also specify the NOIGNORECASE switch (/NOI) when linking. The linker converts function names to upper case by default, but CRTLlib.DLL is built with lower case function names. If you don't use the /NOI switch, the C library functions are not found when you run your application. Finally, you must remember to include the file CRTDLL.OBJ when linking the DLL, and CRTEXE.OBJ when linking the .EXE file. You can ignore CRTEXE.OBJ if you only use functions which require no initialisation, such as the string manipulation functions. See Figure 5 for the link information required.

The CRTLlib DLL is created under user-control, by a command file supplied with the compiler (CDLLOBJS.CMD). This lets you include only those functions which your applications need - to save disk space and RAM - although I would caution against it. It is better practice to place all the C functions into the CRTLlib DLL, otherwise you will get into trouble when the requirements of your application and someone else's, installed on the same machine, do not coincide. The file containing this DLL is not shipped with the operating system, so if your application uses the CRTLlib, ensure that a copy of it goes out with your software.

## Building DLLs

The source code for DLLs is written in the same way as for .EXE modules. The main difference lies in the definitions (.DEF) file supplied to the linker. The definitions file contains ASCII text which identifies the procedures to be exported from the DLL being linked. A definitions file can be supplied for programs as well as DLLs: Figures 1 to 3 show the .EXE triangle program, with definitions files for both the application (.EXE) and the DLL.

```
whole: triang.dll main.exe
triang.dll:   triang.obj
             link /co /nod triang.obj,triang.dll,,doscalls llibcdll,triang.def;
triang.obj:   triang.c
             cl /zi /Od /c /W3 /Alfu /G2s /FPa triang.c
main.exe:     main.obj
             link /co /nod main.obj,main.exe,,doscalls llibcex,main.def;
main.obj:     main.c
             cl /zi /Od /c /W3 /AL /G2s /FPa main.c
```

*Figure 3 - MAKE file for the triangle application*

Figure 4 - Modifications to triangle EXE for DosLoadModule

```
*****  
/* This is the main program for */  
/* the triangle application. */  
*****  
#include <stdlib.h>  
#include <stdio.h>  
#define INCL_DOSMODULEMGR  
#include <os2.h>  
  
int main(argc, argv, envp)  
int argc;  
char *argv[];  
char *envp[];  
(* Sides of triangle *)  
double a,b,c;  
(* Buffer for  
LOAD MODULE errors *)  
CHAR FailBuff[255];  
/* DLL module handle */  
HMODULE ModHandle;  
/* Pointer to TRIANG function */  
int (pascal far *triang)  
(double, double, double);  
  
/* Check the arg count is correct  
- quit if it isn't */  
if (argc < 4) {  
    printf ("Usage: TRIANG a b c\n"  
    "where a, b, c are"  
    " sides of the triangle\n");  
    return (-1);  
} /* endif */.  
  
/* Unpack the arguments */  
a = atof(argv[1]);  
b = atof(argv[2]);  
c = atof(argv[3]);  
  
/* Do the dynamic link  
of the triangle DLL */  
DosLoadModule( FailBuff,  
    sizeof(FailBuff),  
    "TRIANG1", &ModHandle );  
DosGetProcAddress( ModHandle,  
    "TRIANG", &triang );  
  
/* Make an INDIRECT call to the */  
/* triangle procedure */  
switch (triang(a, b, c)) {  
case 0:  
    printf("Equilateral triangle\n");  
    break;  
case 1:  
    printf("Isosceles triangle\n");  
    break;  
case 2:  
    printf("Scalene triangle\n");  
    break;  
default:  
    printf("Impossible triangle\n");  
    break;  
} /* endswitch */  
  
/* Free the triangle DLL off */  
DosFreeModule( ModHandle );  
  
/* Return to OS/2 */  
return (0);  
}
```

The important definitions file directives for DLLs are the LIBRARY, EXPORTS and DATA commands. The LIBRARY statement identifies the file as a DLL, so that the linker knows not to search for a main entry point. The statement can optionally contain the INITINSTANCE or INITGLOBAL modifiers. These determine whether the library initialisation procedure is called once only, or each time a new process links to the library. The EXPORTS directive informs the linker which function addresses are available as entry points. Finally, the DATA statement indicates whether data is shared by all processes using the DLL, or private to each process. This is controlled by the SHARED/NONSHARED and SINGLE/MULTIPLE parameters. Here is the definitions file for the example .EXE

module:

```
IMPORTS  
    TRIANG.TRIANG
```

and here is the file for the DLL:

```
LIBRARY  
EXPORTS  
    TRIANG
```

Figures 1 to 3 contain the source code and MAKE files to build .DLL and .EXE files which solve the famous .EXE triangle program, as featured in *The Third Side*. Figures 4 and 5 show the modifications required to use CRTLlib, and to load the DLL with the DosLoadModule() and DosGetProcAddr() system calls.

## Debugging DLLs

Dynamic Link libraries can be source-level debugged with the CodeView debugger, provided that they are not accessed via calls to DosLoadModule() and DosGetProcAddr() - in this case the physical addresses that CodeView requires are not available until the module has been loaded into memory. It is possible to get round this by IMPORTing an arbitrary address from the DLL being debugged. This forces the DLL to be loaded along with the executable module, and addresses are resolved correctly. Once the debugging is complete, the import can be deleted from the definitions file.

When debugging DLLs, the /L (Library) switch is used to identify the DLL to CodeView. Multiple libraries may be debugged by specifying each one on the command line. The /L parameter must be specified on the command line before the executable file being debugged. If you put it afterwards, CodeView assumes that it is a parameter of the program being debugged. There must be a copy of the DLL in the current directory for CodeView to enter the library successfully.

## Common Problems

So, you've built your EXE and DLL without any compile or link errors. You now try to run it. The system prints the message *Unable to find the file .* and returns you to the command prompt. What do you

do next? This is typical of the often cryptic, and sometimes incomprehensible, error messages which OS/2 produces when DLL problems occur. I have spent many hours trying to track down such problems. Here are a few of the best.

'The system cannot find the file .', or alternatively, 'The system cannot find the file XYZ.DLL' is caused by the DLL not appearing in the LIBPATH. When the loader loads a DLL into memory, it searches the directories specified by the LIBPATH statement in the CONFIG.SYS file. If the DLL is not in a subdirectory specified in your LIBPATH, you will receive the above message. Either move the DLL into a directory in the LIBPATH, or to update the LIBPATH and reboot.

The message 'SYS2070: Unable to demand load the application's segment' is my favourite for incomprehensibility. This is generally caused by a missing entry point. It often occurs as a result of switching to the CRTLlib library, and forgetting to link with the /NOI option. The solution is to ensure that all the entry points you require are actually stored in the DLL, and the case of identifiers matches. The 'SYS2070' error message can also occur when a DLL has no static data segment. This can be cured by defining a single static variable in one of the source files.

Problems can occur at the link stage. If you have problems with unresolved externals or multiply-defined symbols, ensure that you are linking with the correct libraries: specify /NOD to ensure that the default C libraries aren't being searched, and include either LLIBCDLL or CRTLlib as the libraries. Don't include any of the standard C libraries, such as LLIBCA, LLIBC7 etc.

One final point to watch for is the unresolved symbol \_\_FAC. This occurs when returning floating point numbers from functions. The solution here is either to pass a pointer to the floating point variable to the function, or to declare the function of type PASCAL.

**EXE**

Graeme Burton is a freelance programmer, currently working for IBM.

```
whole: triang.dll main.exe  
triang.dll: triang.obj  
link /co /nod /noi triang.obj d:\ibmc2\lib\crtddll.obj,triang.dll,,doscalls  
crtlbin,triang.def;  
triang.obj: triang.c  
cl /Zi /Od /c /W3 /Alfu /G2s /Id:\ibmc2\include\mt /DDLL triang.c  
main.exe: main.obj  
link /co /nod main.obj,main.exe,,doscalls llibce;  
main.obj: main.c  
cl /Zi /Od /c /W3 /Al /G2s main.c
```

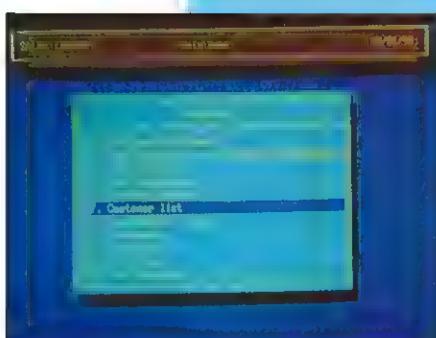
Figure 5 - MAKE file for DosLoadModule and CRTLlib

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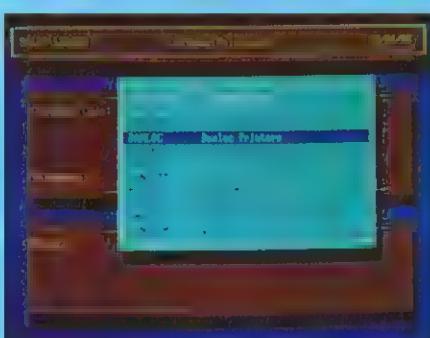
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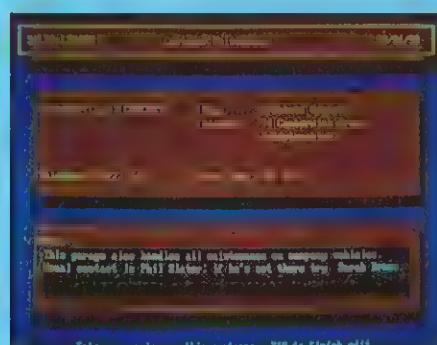
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CIRCLE NO. 114

# Turbo Pascal OOP

## Text Windows

*We have long been hearing about the advantages of class libraries. There haven't been many practical examples about, though - so David Bolton wrote his own.*

Turbo Pascal V3.0 and later support a simple form of text windowing on 80 column CGA/Mono screens. Borland's CRT unit allows a section of screen to be 'cordoned off'. Many of the CRT procedures and functions work relative to this window, so that cursor positioning, scrolling, colours and text I/O are all confined within it. It is crude, but it handles much of the donkey work and simplifies the task of adding a decent front end.

A couple of years ago I wrote a simple Windows system, based around the `Move` procedure (which copies contiguous blocks of memory). It was handy for displaying error messages and help screens, but it was not a full windowing system.

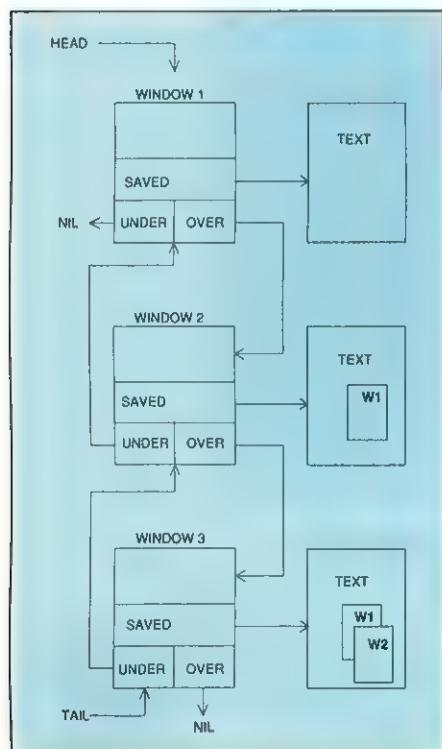


Figure 1 - Structure diagram with three open windows

When Turbo Pascal V5.5 appeared, I decided to redesign my existing windows code, making it object oriented and also try to improve its performance. The original code used an array of window records, and windows could only be opened and closed in order. I also wanted my OOP code to be flexible, so that when I could afford a better micro, the code would take advantage of features like VGA without having to start all over again. With such thoughts in my head, I took another look through my non-OOP code, and did the only thing possible: juked it.

### Design Thoughts

What is a window? Just an area of screen defined by co-ordinates, size, and a title. Add in two pointers to link into other windows and that is the simplest class of window, defined in my program as the object `ClassWindow`. Co-ordinates and dimensions were made word sized so that the objects could be used with graphics screen modes.

The design handles multiple windows and lets them be opened and closed in any order. Windows can be moved about, resized and any window moved from behind any other. The text in the window isn't preserved when windows are moved about, though with a little extra work this could be added.

The structure I chose was a linked list of window objects, with each object dynamically created. I had originally thought of each window as a statically declared object, accessed with code along the lines of `Window1^.Init`. However, as I had decided to store the objects as a linked list, purely static windows were out of the question. Accessing an object had to be done either indirectly, as in `Window1^.Init`, or through a pointer (internal to the object) to the Window data.

The second method was rejected, as it would require the object type defined outside the object definition. This would have lost much of the advantages of OOP, such as inheritance. I toyed with defining the data part as an object, but that line of thinking brought me back to my first idea. This was the indirect method, with objects created on the heap. Borland's OOP implementation supports this with extensions to `New` and `Dispose`.

The list is a double chain with two pointers in each object. The lists firmly anchored between a head and tail pointer. When a Window is opened, it is added to the end of the list, using the tail pointer. This allows easy access to any object from either direction. It so happens that the head pointer isn't used in my program, but I've left it in.

I tried to isolate those elements which are general to any windows (graphic or text based) and put those in `ClassWindow`. `OpenWindow` hooks a window onto the end of the list, and `CloseWindow` removes it. These apply to any window system derived from `ClassWindow`.

`ClassWindow` and its methods do not create a fully working window system; they create an extensible structure which can be built on. Attributes that must be added in descendant objects include the method of storing the screen under the window, colours and border type. These are handled in different ways in a text or graphic system. I have left out other attributes, like shadowing and growing a window, to keep the code compact.

The object type `ColTextWind` was derived from `ClassWindow` to manipulate windows on a text screen, with colours, borders and text saved out from beneath the window. Though designed for colour systems, with very slight modifications it will run on mono systems. (In fact, it does in its present form, but is

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\*Written by Neil Shantz of the British Standards Institution (BSI) and printed in Personal Computer World June 1989, page 241.

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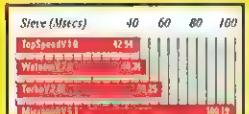


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*Figure 2 - Window objects code*

```

{SR+, St+, I+, D+, F-, V-, B-, N- }
{SM 10000, 0, 60000 }
PROGRAM EXWIND;

USES CRT, DOS;

CONST
  BufferSize=4000;

TYPE
  Windowptr = ^ ClassWindow;
  TitleType = STRING[20];

ClassWindow= OBJECT
  Xpos, Ypos :WORD;
  Xsize, Ysize :WORD;
  Open :BOOLEAN;
  Title :TitleType;
  Over, Under :Windowptr;
  CONSTRUCTOR Init (NewTitle:TITLETYPE);
  PROCEDURE OpenWindow(Atx,Aty,Xlength,Ylength:WORD);
  VIRTUAL;
  PROCEDURE CloseWindow; VIRTUAL;
  FUNCTION IsWindowOpen: BOOLEAN;
  PROCEDURE MoveWindow(TOX,TOY:WORD);
  PROCEDURE CurrentWindow; VIRTUAL;
  DESTRUCTOR Done; VIRTUAL;
END; { ClassWindow }

BorderType= (NoBorder, SingleBar, Doublebar);
SavedText= ARRAY[1..BufferSize] OF CHAR;
SavedPtr = ^SavedText;
Coltype = 0..15;

ColWindPtr= ^ColTextWind;

ColTextWind= OBJECT(ClassWindow)

  Edge : BorderType;
  Saved : Savedptr;
  WindowCol:BYTE;

  CONSTRUCTOR Init (NewTitle:TitleType;
    TheEdge: BorderType;
    TextCol, Backcol: ColType);
  VIRTUAL;
  PROCEDURE OpenWindow(Atx,Aty,Xlength,Ylength:WORD); VIRTUAL;
  PROCEDURE CloseWindow; VIRTUAL;
  PROCEDURE OpenWide; VIRTUAL;
  PROCEDURE RestoreScreen; VIRTUAL;
  PROCEDURE ClearWindow(Textcol,Backcol:ColType);
  DESTRUCTOR Done; VIRTUAL;
END; { ColTextWind }

VAR Head,Tail:Windowptr;
OS:STRING[80];

CONSTRUCTOR ClassWindow.Init
  (NewTitle:TitleType);
BEGIN
  Title:=NewTitle;
  Over:=Nil;
  Under:=Nil;
  Open:=False;
END;

FUNCTION ClassWindow.IsWindowOpen:BOOLEAN;
BEGIN
  IsWindowOpen:=Open;
END;

PROCEDURE ClassWindow.OpenWindow(Atx,Aty,
  Xlength,Ylength:WORD);
BEGIN
  Open:=True;
  Over:=Nil;
  Under:=Tail;
  Tail:=Self;
  IF Under = NIL
    THEN Head:=Tail
    ELSE Under^.Over:=Tail;
END;

PROCEDURE ClassWindow.CloseWindow;
VAR Temp:Windowptr;
BEGIN
  Open:=FALSE;
  IF Under <> NIL THEN
    BEGIN
      Temp:=Under;
      Temp^.Over:=Over;
    END;
  IF over<>NIL THEN
    BEGIN
      Temp:=Over;
      Temp^.Under:=Under;
    END;
  IF Tail=Self THEN
    BEGIN
      Tail:=Under;
      Head:=Tail;
    END
  ELSE
    IF Head=Self THEN
      Head:=Over;
END;

PROCEDURE ClassWindow.MoveWindow(TOX,TOY:WORD);
BEGIN
  CloseWindow;
  OpenWindow(Tox,Toy,Xsize,Ysize);
END;

PROCEDURE ClassWindow.CurrentWindow;
BEGIN
  CloseWindow;
  OpenWindow(Xpos,Ypos,Xsize,Ysize);
END;

DESTRUCTOR ClassWindow.Done;
BEGIN
  IF Open THEN CloseWindow;
END;

VAR Dummy, ScreenAdd:SavedPtr;
Soff:WORD;

({$F+})FUNCTION HeapFunc(Size:Word):INTEGER;
BEGIN
  Heapfunc:=1;
END;
({$F-})

PROCEDURE CopyDummyToScreen;
BEGIN
  MOVE(Dummy^, ScreenAdd^, 4000);
END;

PROCEDURE CopyScreenToDummy;
BEGIN
  MOVE(ScreenAdd^, Dummy^, 4000);
END;

PROCEDURE CopyToDummy(S:SavedPtr);
BEGIN
  MOVE(S^, Dummy^, 4000);
END;

PROCEDURE CopyFromDummy(S:SavedPtr);
BEGIN
  MOVE(Dummy^, S^, 4000);
END;

PROCEDURE Cursor(TopLine, BottomLine : BYTE);
VAR Regs:REGISTERS;
BEGIN
  WITH Regs DO
    BEGIN
      Ax := 1 shl 8;
      Cx := TopLine shl 8 + BottomLine;
      INTR($10,Regs);
    END;
END;

PROCEDURE CursorOff;
BEGIN
  Cursor(48,0);
END;

PROCEDURE CursorOn;
BEGIN
  IF Soff=$B000
    THEN Cursor(13,14)
    ELSE Cursor(5,6);
END;

CONSTRUCTOR ColTextWind.Init(
  NewTitle:TitleType;
  TheEdge: BorderType;
  TextCol,Backcol: ColType);
BEGIN
  NEW(Saved);
  IF Saved=NIL THEN
    BEGIN
      ColTextWind.Done;
      Fail;
    END;
  Classwindow.Init(NewTitle);
  Edge:=TheEdge;
  WindowCol:=(Backcol shl 4)+Textcol;
END;

PROCEDURE ColTextWind.OpenWide;
TYPE CBL=ARRAY[1..6] OF CHAR;
ST80=STRING[80];

CONST
  CHD:CBL={#201,#1B7,#200,#188,#205,#186};
  CHS:CBL={#218,#191,#192,#217,#196,#179};
  CHBL:CBL={' ',' ',' ',' ',' ',' '};
  VAR DMR:WORD;

  PROCEDURE DGoToXY(X, Y:WORD);
  BEGIN
    DWR:=(Y+YPOS-1)*160+((X+XPOS-1)SHL 1);
  END;

  PROCEDURE DWrite(S:ST80);
  VAR I:INTEGER;
  BEGIN
    FOR I:= 1 TO LENGTH(S) DO
      BEGIN
        MEM[SEG(DUMMY")]:=DWR:=ORD(S[I]);
        MEM[SEG(DUMMY")]:=DWR+1:=WindowCol;
        INC(DWR,2);
      END;
  END;

```

limited in its colours.) The procedure IsCorM detects where the screen is located, so the routines work on both mono or colour systems. Figure 1 shows the structure with three windows open.

## How it works

A 4000 byte shadow screen (called Dummy) is first created on the heap. All screen updates are performed in this screen, then copied back to the real screen using the Move procedure. This avoids any flicker and makes updates look smooth and professional. In fact, the CGA adapter supports four screen buffers in text mode, which can be used for this purpose. I considered this approach, but adopted the heap method because it is portable to mono screen systems.

Each window object is created by `ColTextWind`.`Init`, a procedure called from `New`. Its first action is to try and grab 4000 bytes from the heap. If this fails, `New` returns a `Nil` value and `Init` exits through `Fail`,

a Borland extension which handles objects that initialise unsuccessfully. `Fail` deallocates the object and exits. The heap error function `HeapFunc` stops `New` from bombing out if there is not enough RAM, returning a `Nil` value instead.

When a window is opened, `ClassWindow::Open` puts the object on the end of the list. The routine `OpenWide` does most of the work creating the window. Before it starts, it makes its own copy of the shadow screen - which is used as a record of the image before a window is put down.

The window's border is created in the shadow screen and the window cleared before the shadow screen is copied onto the screen. Finally the CRT's unit's Window defines the window limits so all screen writes, scrolls are kept within the required region.

The shadow screen routines (DGoto, DWrite and DClear) are equivalent to GoToXY, Write and ClrScr in CRT. I

have written them in Pascal, though they would be best rewritten in assembler for speed. They are just about fast enough on my 8 MHz Amstrad PC1512.

The Copy . . . procedures use Borland's Move procedure to transfer 4000 byte blocks between the heap, shadow screen and the screen. These routines could also be rewritten in assembler and the screen underneath the window saved out, rather than the entire screen. However, I was being lazy: I used Move as a quick and easy way to save out an entire screen.

When a window is closed, it puts back its copy of the shadow screen using `RestoreScreen`. This takes it, and all open windows above it, off the screen. `ClassWindow.CloseWindow` removes the window from the list, then all windows above it are reopened. This all takes place in the shadow screen which is finally copied back to the main screen. Moving a window involves closing it, changing its co-ordinates and then reopening it. As it has added itself

Figure 2 - Window objects code

```

END;
END;

PROCEDURE DCLEAR(LX, LY:WORD);
VAR S:ST80;
I,BYTE;
J,WORD;
BEGIN
S:=COPY(OS,1,LX);
FOR I:= 1 TO LY DO
BEGIN
J:=DWR;
DWrite(S);
DWR:=J+160;
END;
END;

VAR Lp, IX, Iy, Lt, X2, Y2, X3, Y3, X4, Y4:WORD;
XS:STRING[40];
Chb:Cba;
BEGIN [OPENWIDE]
CopyFromDummy(Saved);
Open:=TRUE;
X2:=Xpos+Xsize-1;
Y2:=Ypos+Ysize-1;
CASE Edge OF
NoBorder:Chb:=Chb1;
SingleBar:Chb:=Chd;
DoubleBar:Chb:=Chd;
END;
DGoToXY(1,1);
DWrite([CHB[1]]);
Y3:=1;
X3:=1;
X4:=Xsize;
Y4:=Ysize;
XS:='';
FOR IX:= 1 TO Xsize-2 DO
XS:=XS+CHB[5];
DGoToXY(X3+1,Y4);
DWrite(XS);
IF Title<>'' THEN
BEGIN
Lt:=LENGTH>Title;
IF Lt>Xsize THEN Title:=COPY>Title,1,Lt-2;
Lp:=(Xsize-Lt) DIV 2;
DELETE(Xs,Lp,Lt);
INSERT>Title,Xs,Lp;
END;
DGoToXY(X3+1,Y3);
DWrite(XS);
FOR IY:= 2 TO Ysize-1 DO
BEGIN
DGoToXY(X3,IY);DWrite([CHB[6]]);
DGoToXY(X4,IY);DWrite([CHB[6]]);
END;
DGoToXY(X4,Y3);DWrite([CHB[2]]);
DGoToXY(X3,Y4);DWrite([CHB[3]]);
DGoToXY(X4,Y4);DWrite([CHB[4]]);
DGoToXY(2,2);DClear(XSIZE-2,YSIZE-2);

```

```

WINDOW(XPOS+2,YPOS+2,X2,Y2);
END;

PROCEDURE ColTextWind.OpenWindow(Atx,Aty,
Xlength,Ylength:WORD);
BEGIN
CursorOff;
ClassWindow.OpenWindow(Atx,Aty,Xlength,Ylength);
OpenWide;
CopyDummyToScreen;
CursorOn;
WINDOW(Atx+2,Aty+2,Atx+Xlength-1,Aty+Ylength-1);
END;

PROCEDURE ColTextWind.RestoreScreen;
BEGIN
CopyToDummy(Saved);
END;

PROCEDURE ColTextWind.CloseWindow;
VAR Temp:ColWindptr;
Otemp:Windowptr Absolute Temp;
BEGIN
CursorOff;
RestoreScreen;
ClassWindow.CloseWindow;
Temp:=@Self;
WHILE Temp^.Over<>NIL DO
BEGIN
Otemp:=Temp^.Over;
Temp^.Over:=Temp^.OpenWide;
END;
CursorOn;
END;

PROCEDURE ColTextWind.ClearWindow(Textcol,
Backcol:ColType);
BEGIN
WindowCol:=(Backcol SHL 4)+TextCol;
CurrentWindow;
END;

DESTRUCTOR ColTextWind.Done;
BEGIN
IF Open THEN CloseWindow;
IF Saved<> NIL THEN Dispose(Saved);
END;

PROCEDURE IsCorM;
BEGIN
IF (MEM[0000:1040] AND 48) <> 48
THEN Scoff:= $B800;
ELSE Scoff:= $B000;
ScreenAdd:=PTR(Scoff,0);
END;

CONST
MaxWind=10;
VAR l,t:INTEGER;

```

```

Wind:ARRAY[1..Maxwind] of Colwindptr;
Tl:STRING[7];
BEGIN
RANDOMIZE;
OS:='';
FOR i:= 1 TO 80 DO
OS:=OS+' ';
IsCorM;
Tail:=NIL;
Head:=NIL;
NEW(Dummy);
Hesrror:=@HeapFunc;
FOR i:= 1 TO MaxWind do
BEGIN
STR(i:Tl);
Wind[i]:=NEW(ColWindptr,
Init(Tl, BorderType(RANDOM(2)+1), WHITE, BLACK));
IF Wind[i]=nil THEN
BEGIN
Writeln('Halted- Initialisation Error');
HALT(1);
END;
END;
TEXTBACKGROUND(0);
TEXTCOLOR(15);
CLRSRC;
FOR i:= 1 TO 20 DO
Writeln('*****');
CopyScreenToDummy;
FOR i:= 1 TO MaxWind do
wind[i]^ .OpenWindow(1*i,i,RANDOM(35)+5,RANDOM(5)+4);

REPEAT
REPEAT
READLN(Tl);
VAL(Tl,T,i);
UNTIL i=0;
IF (t>MaxWind) AND (t<=MaxWind*2) THEN
BEGIN
Wind[t-MaxWind]^ .ClearWindow(RANDOM(15),
RANDOM(15)+1);
END
ELSE
IF (t>0) AND (t<=MaxWind) THEN
BEGIN
Wind[t]^ .MoveWindow(RANDOM(36)+1,
RANDOM(12)+1);
END;
UNTIL t=0;

FOR i:= MaxWind DOWNTO 1 DO
Dispose(Wind[i].Done);
CopyDummyToScreen;
END.

```

onto the end of the list, it automatically becomes the current window, and appears in front of all the others.

The program can be easily converted into a unit. There are a few points to watch when doing this.

- Ensure that you have enough heap RAM. My demonstration program uses ten windows, each taking just over 4000 bytes, plus another 4000 bytes for the shadow screen. This RAM must be obtained before you do anything else. Also, the Head and Tail pointers must be both preset to Nil.
- After clearing the main screen, remember to call CopyScreenToDummy, other-

wise it will look very messy when the shadow screen gets copied onto the screen.

It is probably safer to put some or all of this code into the unit initialisation section, so it gets called before the main program executes.

## The Demonstration

Ten random sized windows are opened. Typing in a window number (1-10) will move the window to a new random position and have all I/O redirected there. Type in 11-20 and the window (number-10) will change colour and become current, staying in the same place but moving to the top. Type in 0 and it disposes of all of the windows by calling the destructor Done for each. If a window was open, it is closed, and its storage space returned. Figure 3 summarises the use of the window objects.

During the development of this windowing system, I encountered a problem with assigning pointers. If you examine the code with a keen eye, you'll see the variable Otemp in ColTextWind.CloseWindow. Although the line Temp:=Temp^.Over is perfectly valid, it will not compile. After much hair pulling and chatting with Borland, I established that it was a compiler bug. It appears that the strict pointer type checking is just too strict. Otemp, which is declared as a pointer to ClassWindow at the same location as Temp, is the fudge that I used to get out of this. Thanks to Borland's technical support for confirming the bug and saving the rest of my hair!

EXE

```

Var W1:ColWindptr;

New(Dummy);
Head:=Nil;
Tail:=Nil;
CopyScreenToDummy;

W1:=NEW(ColWindptr,Init>Title,Edge,Text Colour,Background Colour))
W1^.OpenWindow(Atx,Aty,LengthX,LengthY);

W1^.CloseWindow;

W1^.Done;

```

Figure 3 - Example code for Window objects

*David Bolton is 31, a graduate, and an experienced Turbo Pascal programmer. He runs BATPUG, the independent Turbo Pascal user group (write to 12 Clegg Avenue, Thornton, Cleveleys, Blackpool, LANCS FY3 1BJ for details of this group). His hobbies include Badminton, board and computer games and, in the last few weeks, getting married.*

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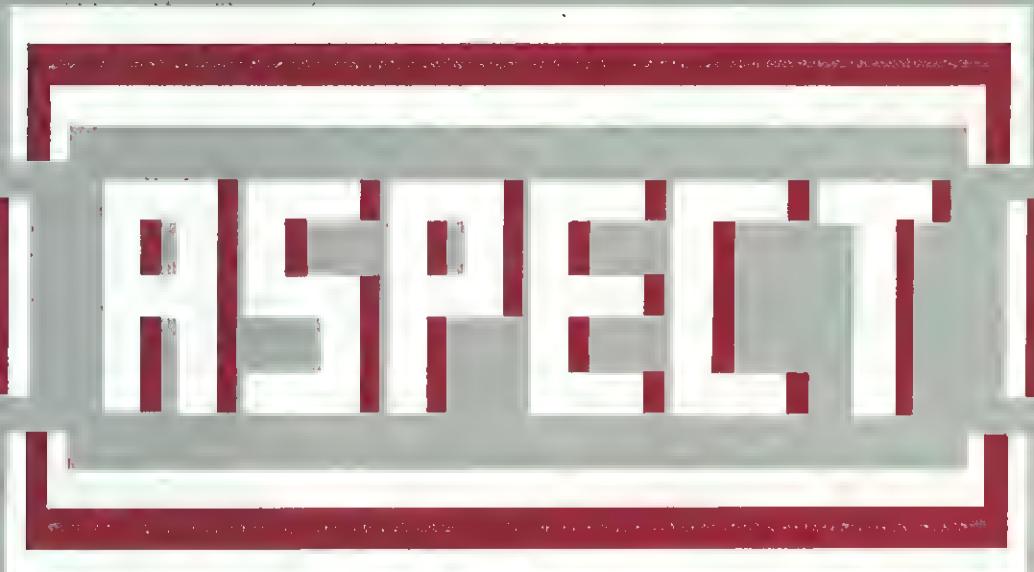
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# A Real Time Pioneer

*They don't build 'em like this any more. You'd better hurry, or you'll miss your last chance to see working examples of a venerable old programming language, as Jim Cooling explains.*

As time goes by, new programming languages are introduced, some are improved, some just fade away. So most experienced software designers end up with a good working knowledge of a number of languages, working (hopefully) with state-of-the-art techniques. Many programmers retain a soft spot for a particular language which they met along their career path. For me that language is CORAL 66, Computer On-line Real-time Application Language.

CORAL 66 has its roots in the UK defence industry. It is still the most widely used high-level programming language in that area, although eventually it will succumb to the Ada steamroller. Even after 24 years, its low-level facilities (in terms of ease of use, visibility, clarity and power) are matched by few of its successors.

What were the objectives of its designers? It's probably best to stress what they didn't set out to do: ie to rival COBOL in the business world or FORTRAN for number crunching. CORAL 66 was designed to be used as a general purpose programming language for real-time embedded systems. The intended targets were small to medium sized dedicated computers, frequently being applied to control applications (it was, for instance, widely used on the Ferranti Argus minicomputer in shipboard Radar and Weapon systems). Further, it was developed to support both fixed point and floating point arithmetic for such real-time functions. And, most importantly, its primary objective was to reduce software costs.

How was this reduced cost to be achieved? The designers considered that the increased productivity attainable by using a

high-level programming language would lead to:

- Lower programming costs.
- Faster implementation of designs.
- Simplified and reduced maintenance efforts.

It was also realised that these goals couldn't be attained without suffering drawbacks. Compared with assembly language programs, CORAL 66 programs would need more store space and would take longer to execute. At that time, the primary store in computers was magnetic core, which was heavy, large and slow. Even so, it was deemed that the advantages far outweighed the disadvantages. Given the circumstances, this was a brave decision.

The language's design roots were in JOVIAL, a language developed by the United States Air Force in 1959. The other major influence was ALGOL 60, 1960. Clearly it was going to be a block structured language, though some features of FORTRAN were incorporated.

## Program Layout

The simplest type of CORAL 66 program consists of a single compilable unit, structured as shown in Figure 1. A block section is defined using the predefined ('basic') words BEGIN and END. Program declarations are made within the block, restricting the scope of declared items to that block. Basic words are enclosed in single quote marks. The official definition of the language recommended that such words should be written in upper case, all others being in lower case - the form shown here was permitted as an alternative. However, at the time that language compilers began to be produced in earnest, data terminals which could handle both cases were quite expensive. Hence many compilers allowed the programmer to write source code using the single case form (more precisely, they

### 1962 - Original definition of CORAL

**1965** - The Royal Radar Establishment (RRE) began the project by producing an initial definition of CORAL. This, later formalised as CORAL 64, was a subset of JOVIAL.

**1966** - CORAL 66 was devised by IF Currie and M Griffiths, aimed for applications running on minicomputers.

**1967 to 1969** - Compilers were produced for a number of machines, including the Marconi Myriad and the Plessey XL4.

**1970** - CORAL 66 was specified as the preferred language for UK defence projects. The official definition of the language, written by PM Woodard, PR Wetherall and B Gorman, was published by HMSO.

**1973** - As a result of discussions between the Department of Industry and various manufacturers and trade associations, a CORAL 66 support organisation was formed.

- Technical support - RRE.
- Promotion, education and information - National Computing Centre.

**1974** - Major conference: 'CORAL 66 The real-time language for current use'.

**1980** - Standardised by the British Standards Institute as BS5905:1980.

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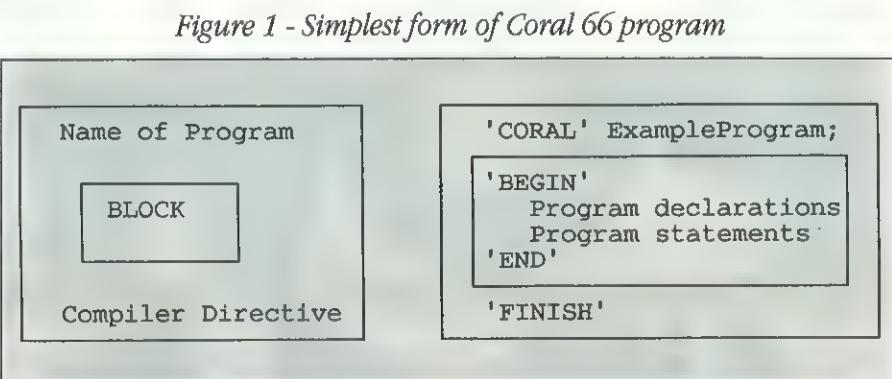
were generally case insensitive).

The smallest unit which can be compiled on its own is called a segment (nothing to do with 80x86 segments) delimited by the basic words BEGIN and END. Most well-designed practical programs consist of a number of segments, providing the programmer with extensive information hiding facilities. Segments can be compiled in separate files, then linked together. There are various facilities to allow communication between separately linked modules: COMMON (to access another part of the application, in another segment), LIBRARY and EXTERNAL (to get at library procedures and operating system primitives - LIBRARY is frequently used as an include directive) and ABSOLUTE (to get at an absolute address). These directives are placed at the top of the code module. Difficulties may be met when using communicators, as only COMMON is fully defined; the functions of the others depend on the compiler implementation.

## Structuring Facilities

How well does CORAL 66 support the aims of structured software design? This is an interesting question, as the CORAL 66's language design pre-dates much of the work on structured techniques. What we are looking for in the language are facilities to:

- Build structured programs.
- Implement entities within this (entity is rather an overworked word - perhaps thingy would be better).



- Manipulate and control these entities - program control.

***CORAL 66 is still  
the most widely  
used language,  
although  
eventually it will  
succumb to the  
ADA steamroller***

Modern structured software designs rely heavily on modular program construction and virtual (abstract) software machines.

Segmentation, together with block structuring, gives us a simple and straightforward way of building modules. The virtual machine is implemented using the procedure construct, these coming in three forms: the procedure, the typed procedure and the recursive procedure.

The procedure structure consists of two parts, a header

'PROCEDURE' Proc(Params);  
and a body. Both value and reference (called 'location') parameters may be used. Typed procedures, defined with a header

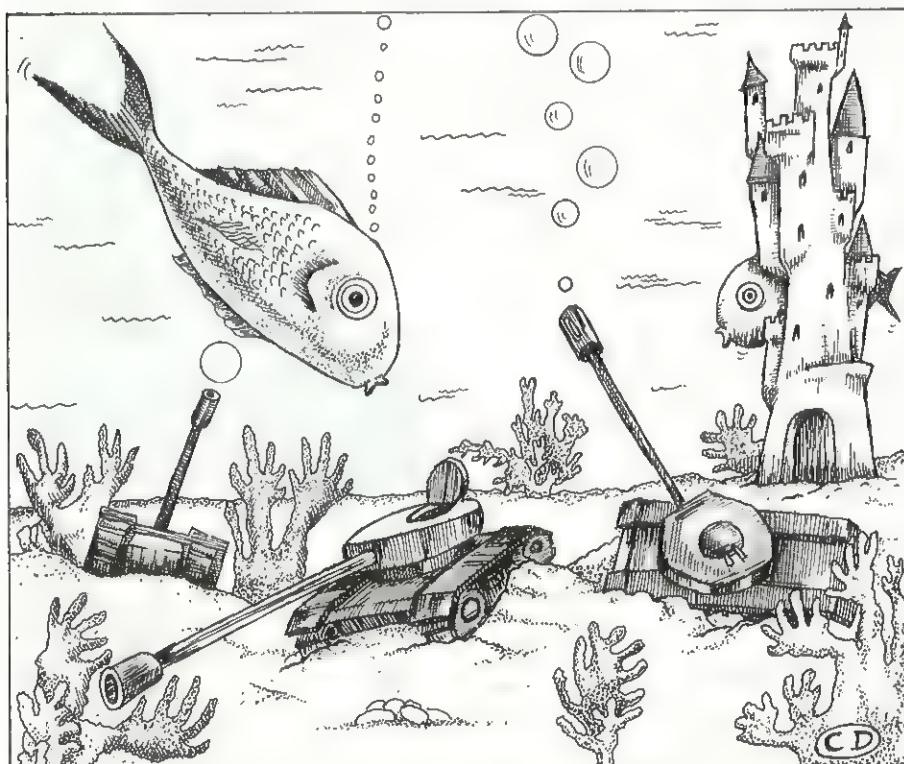
NumType 'PROCEDURE'  
Proc(Params);  
are analogous to Pascal's functions (NumType is 'INTEGER', 'FIXED' etc); they are used where a result is to be passed back from the procedure. The body of this procedure type must contain an 'ANSWER' statement to return the required value. The features of these procedure types should be obvious. The third type, the recursive procedure, differs from the others only in that it is declared using the 'RECURSIVE' keyword and it can invoke itself. In CORAL 66, special code is needed to implement recursion. The high data storage space overhead of recursion makes it an expensive luxury in small embedded systems, so the language designers chose to highlight its use with this mechanism.

Data types fall into two groups: simple (or scalar) and structured. CORAL 66 supports both constructs, but only in a very limited way. Everything is defined in terms of its number representation within the computer, thus the simple types are 'INTEGER', 'FIXED' and 'FLOATING'. Data abstraction is attained by using named variables

'INTEGER' SkinColour,  
UartStatus;

This typing is rather weak - the compiler can check only for structural, and not name, equivalence. For instance, the assignment statement

SkinColour := UartStatus;



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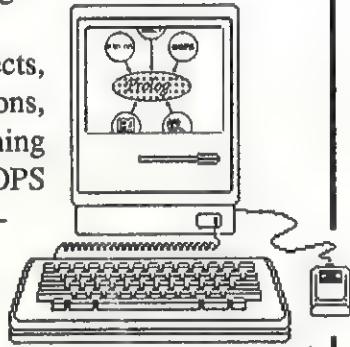
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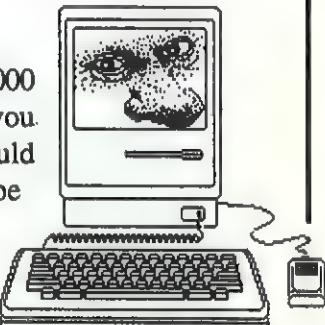
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Figure 2 - Coral 66 control structures

CONDITIONAL CONSTRUCT	CONDITIONAL EXPRESSION
Selection	'IF' ... 'THEN' ...;
Iteration - pre-check loop - post-check loop - fixed looping	'IF' ... 'THEN' ... 'ELSE' ...; 'FOR' ... 'WHILE' ... 'DO' ...; 'FOR' ... 'STEP' ... 'UNTIL' ... 'DO' ...; 'FOR' ... 'STEP' ... 'UNTIL' ... 'DO' ...;

will be accepted as perfectly valid - even if it's nonsense in program terms.

The structured types are the 'ARRAY' and the 'TABLE', but their elements must belong to one of the simple types. CORAL 66 Arrays are one dimensional types, needing little further explanation. The table is similar to a two dimensional array, but having special qualities to allow very efficient packing of data. Moreover, it allows variables of different types to be stored together (in that way it is like the record structure).

CORAL 66 provides a set of control structures which conform to the rules of structured programming: sequence, selection and iteration. These are shown in Figure 2. Program control can also be exercised by the use of labels and GOTO statements (normally considered bad practice, but ideal for use with exception handlers). Labels are normally individual and distinct.

However, one construct, the switch, treats its label as if it is actually a set of labels. For example:

```
'SWITCH' PressureAlarms =
    ExtraLow, Low,
    High, ExtraHigh;
the statement 'GOTO' PressureAlarms[0] transfers control to label ExtraLow and 'GOTO' PressureAlarms[3] transfers control to label High. Using this, a crude form of the case selector mechanism can be built.
```

Most modern programs are built on the concepts of functional structuring of designs, incorporating top-down decomposition, stepwise refinement of the problem, and the use of structured programming within the source code (in spite of the hype, these ideas carry straight across into object oriented design). These are relatively easy to implement in CORAL 66.

## Low-level

In the real time embedded world, computer software and its environment are inseparable items. To build effective and efficient programs we need to access and manipulate system objects (actual and virtual) easily and simply. This involves device access and control, bit manipulation and assembly language interfacing.

For example, suppose that our system has a serial I/O channel, driven by a memory-mapped UART. This device can be named, and its address location declared, in a simple manner:

```
'ABSOLUTE' ('BYTE'
Uart1Data/'HEX'(A005),
Uart1Control/'HEX'(A006));
```

The variable Uart1Data is located at absolute address A005H, its data unit size being a byte. Operations with this variable are straightforward. Very efficient coding can be achieved by using constructs such as:

```
Uart1Control := 'HEX'(40);
```

The programmer can get very close to the object code without having to resort to assembly language coding.

When dealing with hardware devices we often have to interpret and control individual bits (or groups of bits). This is handled by the 'BITS' operator, which works like this:

```
'BITS' [NoOfBitsAccessed, StartPos]
VariableName.
```

This is a very flexible tool, for instance, you can legally write

```
'BITS'[4,0]DacWord :=
'BITS'[4,8]ControlSignal;
```

Working at this level, we invariably find ourselves having to make logical decisions. The logical operators of CORAL 66, 'DIF-FER', 'UNION' and 'MASK', equivalent to Boolean 'exclusive or', 'inclusive-or' and 'and' functions, fulfil this purpose. Nonetheless, it remains almost impossible to develop software for real-time embedded systems without using assembly language programming at some stage. This can be done in CORAL 66 using code inserts. This example shows the saving of register contents in an 8085 processor:

```
'CODE'
-BEGIN'
DI
PUSH PSW
PUSH B
PUSH D
PUSH H
SIZ 5
-END';
```

```
'CORAL' TRIANGLE;
(Program to solve triangle problem in CORAL 66)
'DEFINE' SIDES PER TRIANGLE "3";
'DEFINE' PRINT TEXT "PRTXT";
'DEFINE' GET INTEGER "GETINT";
'DEFINE' PRINT INTEGER "PRTINT";

'COMMENT'
***** External Procedures *****
'EXTERNAL' {
    'PROCEDURE' PRINT TEXT ( 'VALUE' / INTEGER' );
    'PROCEDURE' GET INTEGER ( 'VALUE' / INTEGER' );
    'PROCEDURE' PRINT INTEGER ( 'VALUE' / INTEGER', 'VALUE' / INTEGER' );
}

'COMMENT'
***** Data Declarations *****
'INTEGER' 'ARRAY' SIDE ARRAY [0:2];
'BYTE' COUNTER;

'COMMENT'
***** Code *****
'COMMENT' Read in the three sides of the triangle;
PRINT TEXT ( "Enter three lengths" );
'FOR' COUNTER := 0 'STEP' 1 'UNTIL' SIDES PER TRIANGLE 'DO'
    GET INTEGER ( 'LOCATION' ( SIDE ARRAY [COUNTER] ) );

'COMMENT' Print the three sides;
PRINT TEXT ( "Enter three lengths" );
'FOR' COUNTER := 0 'STEP' 1 'UNTIL' SIDES PER TRIANGLE 'DO'
    PRINT INTEGER ( 5, SIDE ARRAY [COUNTER] );

'COMMENT' Is it a triangle? ?
'IF' SIDE ARRAY [1] + SIDE ARRAY [2] < SIDE ARRAY [0] 'OR'
    SIDE ARRAY [0] + SIDE ARRAY [2] < SIDE ARRAY [1] 'OR'
    SIDE ARRAY [0] + SIDE ARRAY [1] < SIDE ARRAY [2]
    'THEN' PRINT TEXT ( "Not a triangle" )
'ELSE' 'IF' SIDE ARRAY [0] = SIDE ARRAY [1] 'AND'
    SIDE ARRAY [0] = SIDE ARRAY [2]
    'THEN' PRINT TEXT ( "Equilateral triangle" )
'ELSE' 'IF' SIDE ARRAY [0] = SIDE ARRAY [1] 'OR'
    SIDE ARRAY [0] = SIDE ARRAY [2] 'OR'
    SIDE ARRAY [1] = SIDE ARRAY [2]
    'THEN' PRINT TEXT ( "Isosceles triangle" )
'ELSE' PRINT TEXT ( "Scalene triangle" );

'END'
```

Figure 3 - The Triangle Problem

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1988: PC versions enhanced with improved terminal emulation including VT100 emulation, keyboard mapping and facilities to define function keys.

1989: Comprehensive upgrade for unattended operation of multiple PC/host links supporting auto-dialling modems.

1983: Option to control file transfers from command files as an alternative to control from operator's keyboard.

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1982: Terminal emulation facility introduced enabling the use of a terminal on a local computer as a terminal on a remote computer thereby allowing control of file transfer sessions from a single terminal.

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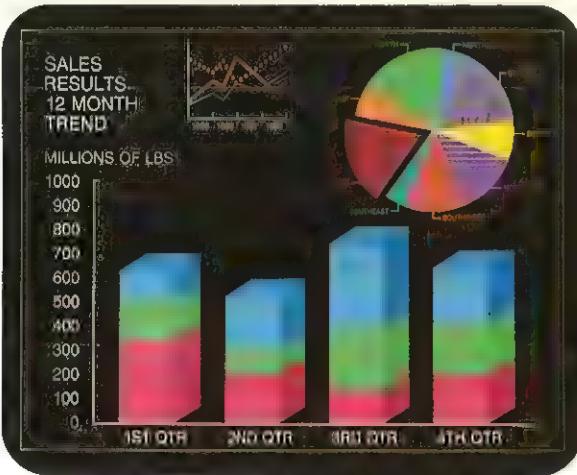
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A feature which fits together well with code inserts is that of the Macro. The language defines the features and use of a macro preprocessor, whose function is to replace one section of source code with another - at compilation time. The informal syntax of the macro-definition is:

```
'DEFINE' NameOfMacro
    < BodyOfMacro >
```

where BodyOfMacro is a text string enclosed in double quote marks. Macro definitions can be used to remove detailed operations from the source code. This could be used with the previous example as follows:

```
'DEFINE' Save
" "CODE"
"BEGIN"
Assembler Statements...
'END'; "
```

Within the actual source code, only the statement SAVE would be used. Macros are also useful alternatives to procedures, to gain execution time, at the expense of code size.

## The Triangle Problem

From what has gone so far, the source code for the Triangle Problem (Figure 3) should be self-explanatory. However, one point is worth a mention. The language has few facilities for the handling of string I/O operations. These are usually written by the user, as and when required. In this particular example, the I/O routines (PRTXT, GETINT and PRTINT) are declared to be outside the program. To improve the readability of the code, these names have been redefined using macros.

CORAL 66 was the unmatched king of real time programming for many years. Why didn't it become widely used when the microprocessor came along? The answer is simple: cost. CORAL 66 compilers have always been comparatively expensive, compared to other languages. Second, the development environments have also been expensive when compared with, for instance, PC-based systems.

In 1980, if you wanted to develop software for, say, an Intel 8085, you would normally need an Intel MDS and a compiler costing

about £2,500. When the 8086 compiler was released (again hosted on the Intel MDS) the price was a staggering £6500. Later, a US company produced a software package which made a standard PC look like an MDS - and compiler costs fell sharply. But, by then, newer languages (such as real time Pascal) had arrived on the scene - and that was the beginning of the end for CORAL 66.

EXE

*Dr Jim Cooling is a senior lecturer in the Department of Electronic and Electrical Engineering, Loughborough University of Technology. He has been deeply involved in the design, development and production of real-time systems for many years, and has published regularly on the subject.*

*Many thanks to Keith Rotton of Transmitton Ltd, Ashby De La Zouch, for producing and testing the triangle problem code.*

*If you are interested in reading further on this subject, then Dr Cooling recommends CORAL 66 Programming (author J T Webb, published by NCC Publications) and his own Software Design for Real-time Systems (published by Chapman and Hall).*

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# A DOS Debugger

*WatchWord is a debugger by Robert Schifreen that watches a word in the PC's memory, and prints its contents whenever they alter.*

When I'm poking around inside DOS, or trying to find why my program's not working properly, I frequently resort to the DEBUG debugger, because it's small and simple. However, one thing that DEBUG doesn't do is to watch the status of a piece of memory, and tell me whenever that area of memory changes. It's not as if you need a 386 machine to do this, either. WatchWord is designed to show just how easy it is to write a simple debugger that allows you to watch memory.

WatchWord is a TSR that sits on two different PC interrupts. First, it sits on the timer interrupt, 1Ch, and this part of the program gets called 18.2 times a second by the PC hardware. Every time this routine is called, it looks at the contents of a specified word in memory. If the contents have changed since the last time the program looked, the new contents (as a word, not a byte) are printed to LPT1. If the contents are the same, no action is taken.

The other interrupt that WatchWord traps is Int 15h, and this provides the interface between your program and the WatchWord debugger. To tell WatchWord which word to watch for, execute an Int 15h call, with AX set to 0FFFh, and the address to watch

in ES:DI. So, if you want to watch the DOS clock change every second, execute Int 15h with AX = 0FFFh, ES = 0 and DI = 046Ch, because the clock tick word is at 0:46Ch.

As the program stands, the watched word defaults to the keyboard status byte at 0:417h. This byte is a bit-mapped area that contains the current state of the Ctrl, Alt and Shift keys. So, once you've assembled WW.COM, and installed it by typing WW at the DOS prompt, press the Ctrl key and hold it down. Your parallel printer should print a value. Now, release the key and a different value will be printed.

The best use for WatchWord is for debugging your own programs. For example, if you want to find out when a certain routine is getting called, have that routine keep a byte in memory, and have that byte set to one every time the routine is entered, and to zero when it is left. Now, if you point WatchWord at that byte, you'll be able to monitor it.

There are a number of ways in which WatchWord can be enhanced. It was, after all, written in a couple of hours, purely to demonstrate that the basics of a debugger can be created quite easily. Feel free to add

a switch to turn printer output on and off (I suggest using Scroll Lock), and the ability to watch a whole block of memory rather than a single word.

The major problem with WatchWord is its timing resolution. The PC automatically generates an Int 1Ch every 18th of a second or so, and I have used this facility to allow WatchWord to watch memory. There is a well-documented method (found, for example, in *The New Peter Norton Programmer's Guide to the IBM PC and PS/2*) of reprogramming the PC's timer chip to increase the number of times per second that an interrupt is generated, and this could easily be used to increase the resolution by a factor of, say, four. If you do this, though, you will have to get involved with intercepting the Int 08h handler. This is the handler which actually receives the hardware interrupt from the clock - Int 1Ch is called from it. If the original Int 08h handler is called at a higher frequency, there are some bizarre side effects. The Norton Utilities SI index of your machine's performance will go down. The floppy disk motor will cut out before the read/write head has reached the selected track. The MS-DOS clock/calendar will run fast, and you'll find that your days start to fly by!

EXE

```

; WW.ASM - Watch a Word
; -----
;
code segment
assume cs:code,ds:code
org 0100h

start:
jmp init

intentl1c:      ; Come here 18.2 times per second
    jmp watch

watchword_seg dw 0          ; Segment of word to watch
watchword_off dw 0417h       ; Offset of word to watch
prev_cont dw 0              ; Previous contents
prtstr db '[XXXX:XXXX] = XXXX',0Dh,0Ah,0

watch:
push si

; WatchWord code starts here
push es
push di
push ax
push bx
push dx

mov es,cs:watchword_seg
mov di,cs:watchword_off
mov ax,word ptr es:[di] ; get contents of watched word
mov bx,word ptr cs:prev_cont
cmp ax,bx ; has the word's contents changed?
je no_change

mov word ptr cs:prev_cont,ax ; The word has changed so print it
mov bx,ax
mov si,offset cs:prtstr ; Construct the print string
inc si ; point si to seg addr in print str
mov ax,word ptr cs:watchword_seg
call bin2asc
mov si,offset cs:prtstr
add si,6
mov ax,word ptr cs:watchword_off
call bin2asc

```

(continued)

Figure 1 - Listing of WW.ASM

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*Figure 1 - Listing of WW.ASM (continued)*

```

mov si,offset cs:prtstr
add si,14
mov ax,bx
call bin2asc      ; Print string is now formatted

; Now print string

mov si,offset cs:prtstr    ;String to output
xor dx,dx                ;Printer LPT1:
prloop:
mov ah,0                  ;Print string
mov al,cs:[si]
cmp al,0
je no_change
int 17h
inc si
jmp prloop

no_change:

pop dx
pop bx
pop ax
pop di
pop es
pop si

db 0EAh      ; Far jump to original Int 1Ch handler
intipic dw 0  ; Address of orig handler, filled by
intcsic dw 0  ; installation code.

intent15:

cmp ax,0FFFFh
jne done
mov word ptr cs:watchword_seq,es
mov word ptr cs:watchword_off,di

done: db 0EAh   ; Far jump to original Int 15h handler
intip15 dw 0   ; Address of orig handler, filled by
intcs15 dw 0   ; installation code.

bin2asc proc near ;Convert AX to ASCII and put at CS:SI
push ax
mov al,ah
call convai
pop ax
convail:
push ax
push cx
mov cl,4
ror al,cl

```

---

```

pop cx
and al,0Fh
add al,30h
cmp al,39h
jbe bin1
add al,7
bin1:
mov cs:[si],al
inc si
pop ax
and al,0Fh
add al,30h
cmp al,39h
jbe bin2
add al,7
bin2:
mov cs:[si],al
inc si
ret
bin2asc endp

init:           ; Install WW
    mov ax,cs    ; Set DS = CS
    mov ds,ax

    mov ah,35h    ; Get old interrupt vector
    mov al,1Ch
    int 21h
    mov word ptr cs:intcslc,es  ; Save in long JMP
    mov word ptr cs:intpic,bx
    mov ah,25h    ; Set new interrupt vector
    mov al,1Ch
    mov dx,offset cs:intent1c
    int 21h

    mov ah,35h    ; Get old interrupt vector
    mov al,15h
    int 21h
    mov word ptr cs:intcs15,es  ; Save in long JMP
    mov word ptr cs:intip15,bx
    mov ah,25h    ; Set new interrupt vector
    mov al,15h
    mov dx,offset cs:intent15
    int 21h

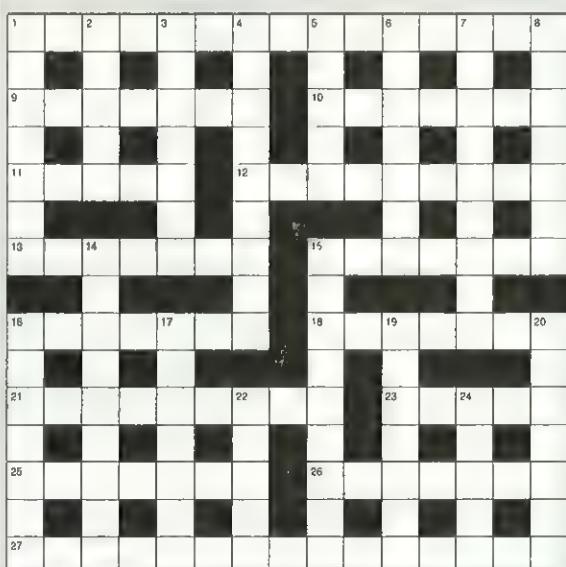
    mov ax,3100h  ; End, with errorlevel 0
    mov dx,(init-start)/16+1  ; Number of resident paragraphs
    int 21h        ; Done
    code ends
    end start

```

## **.EXEWORLD**

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- 1 Getting into IT from scratch (15)
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  - 11 Bird houses set in structured code (5)
  - 12 Climb step by step (9)
  - 13 Links between structures (7)
  - 15 Bars backward Gas buyer from water holes (7)
  - 16 Signals controlled by signals (7)
  - 18 Make a transposition error, say (7)
  - 21 They oppose current change (9)



- 23 Peripheral to the sound sensor, for instance (5)
  - 25 Real opposed to 17 not integer (7)
  - 26 Momentum - laziness to others (7)
  - 27 Apparently unnecessary test on parity, say (10,5)

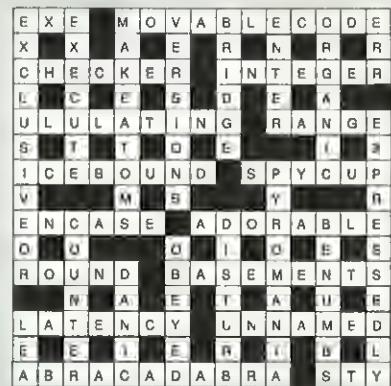
DOWN

- 1 Path for 16ac getting a tunnel (7)
  - 2 Sounds of discontent (5)
  - 3 Journeyman from Homer to Joyce (7)
  - 4 N-type or P-type (9)
  - 5 Capital charge on chip (5)
  - 6 Suitability of fast train crossing  
loch... (7)
  - 7 .. as I train rye to make a journey (9)
  - 8 Neutralises gas on logic circuits (7)
  - 14 Gave up sailor and individual note (9)
  - 15 Re-starts work with a full instruction  
set (5,4)
  - 16 Schmitt made one but not for his  
gun (7)
  - 17 Font chip I broke up in a story... (7)
  - 19 ... and the way oily acid took a chip (7)
  - 20 Put down for yourself sound sensor  
on omr input (7)
  - 22 Final character of old (5)
  - 24 Program name and state reward (5)



### *EXEWORD MAY*

Our apologies, but due to a printing error, May's crossword solution did not appear last month.



.EXEWORLD JUNE

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# Command arguments from program output

*In the first of a new UNIX column, Peter Collinson highlights a feature of UNIX's handling of command line arguments that will be a surprise to MS-DOS programmers.*

I felt that I would like to start my regular column with something that I think is really 'UNIX' - the back-quote operator. This is part of UNIX shell syntax which allows the output from one command or command pipeline to be directly used as arguments to a program. The topic also allows me to highlight some differences between the MS-DOS way of doing things and the UNIX way - just remember that one is never *better* than the other, simply different.

The UNIX command line consists of a command name followed by a number of arguments. For example:

```
ls -la /bin Makefile
```

is a command name `ls`, some program arguments `-la` and some filenames. Another familiar piece of syntax allows filename expansion:

```
ls -l *.c
```

lists all the files whose name ends in `.c`. Of course, there are other forms of expansion permitted by the shell; these were discussed in June's article on regular expressions.

It is important to realise that the expansion is done by the shell *before* the `ls` command is called; the string `*.c` is not passed into the command for it to interpret. The shell sees the star, reads the directory and performs the necessary pattern match while constructing an argument list. The expanded list is sorted and is finally passed into the program as a number of strings.

It is possible to be surprised by the order in which this all happens. For instance, when typing:

```
ls -l * > output
```

the output file will contain its own name. Worse, the size of the file will be shown as zero. This piece of counter-intuitive behaviour is easily explained when it is realised that the output file is created before the `ls` command is even run. Also, when `ls` sees the file, it has just been created by the shell and really is zero length. However, this whole effect can sometimes be embarrassing.

Concentrating the code for all the complicated pattern matching and directory reading in the shell makes sense, since it exists in one program and does not have to be installed in every program on the machine. The expansion mechanism works well when the desired files are all in one directory and their names have a regular structure. It can be deficient if a more complicated selection process is needed.

## Complicated Selections

Consider how you might perform a non-trivial, but nearly repetitive, edit to a number of files; for example, adding a parameter to all occurrences of calls to a routine. The way to do this is to use `grep` to find the files which contain the routine name, so each file can be edited in turn to make the required change. There is a chance that a file will be missed; this is lessened if the editor is called by a command like:

```
vi command.c main.c odds.c
```

since `vi` has commands for stepping through the files one at a time. However, there would be much less chance of a mistake if `vi` could be called with arguments supplied from the output of the `grep` command.

The back-quote operator provides exactly this functionality. It is a general mechanism for constructing argument lists from the output of a command or command pipeline. When a command is placed in back quotes in an argument list, it is run and its standard output is caught by the shell. The output is parsed and supplied to the command at the start of the line as program arguments. The example becomes:

```
vi `grep -l routine_name *.c`
```

`grep` is passed the `-l` option to suppress its normal output; instead it prints a list of filenames on its standard output. A filename will be included in the list when it contains the match string and it is guaranteed to only appear once. The shell reads the list and arranges to call `vi` with the derived arguments. `vi` will run with no arguments if the list is empty.

The back-quote operator simply turns a list of files coming from a program into a set of arguments. It considerably enhances the power of the command line, especially given that UNIX has many programs designed to generate a list of file names. Here is another example:

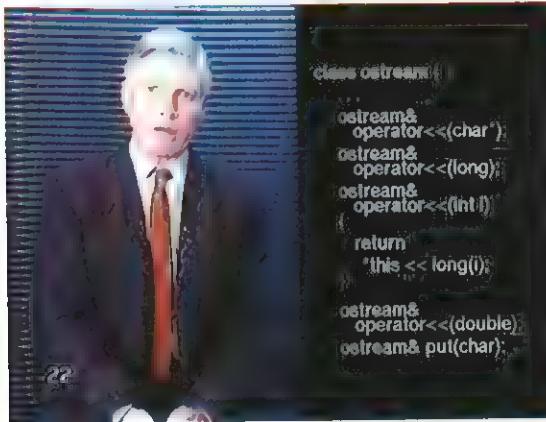
```
tar cf /dev/rst8 \
```

```
'find . -mtime -5 -print'
```

This `tar` command copies files to cassette tape. The file names are taken from the standard output of the `find` command, which, starting from the current directory, will search for files which have been modified in the last five days. The `-print` option to `find` will cause a matched name to be listed on standard output. The shell uses this list as a set of arguments to the `tar` command and the appropriate files are written onto the tape. This command can form the basis of a file backup system.

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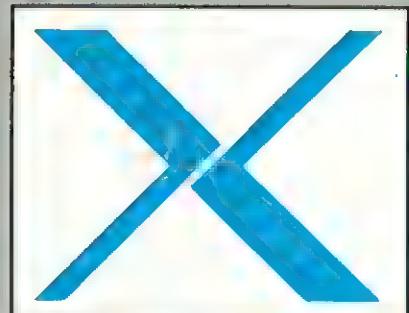
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Thinking with Micros



# System Science

There are many situations where several operations are to be done on a set of unrelated files. Rather than typing the file names in again and again, they can be placed in a file, say sourcedata. The input to the file can be diverse, minimally using the combination of ls and an editor. Then using the syntax like:

```
cp `cat sourcedata` destination
a number of files will be copied.
```

First, the cat command runs, simply copying the list of files to its standard output. The shell captures the list and creates a set of arguments for cp from it. Finally, cp is called copying the set of files to the destination.

## Interactive Selection

It can be tedious to create the source argument file, so the back-quote technique using cat is only appealing when the source file can be used more than once. For one off use, a tiny shell script called pick can be combined with the back-quote operator to allow all commands to have their arguments selected interactively. The job of the pick shell script is simple. It presents its arguments one by one to the user and prints a question mark. If the user answers y, the argument is copied to standard output, otherwise the argument is discarded. The simplest form of pick is:

```
#!/bin/sh
# Very simple pick command
for i in "$@"
do
    echo -n "$i? " > /dev/tty
    read answer
    case "$answer" in
        y*) echo $i ;;
        esac
done < /dev/tty
```

So if we were copying files from the current directory, the cp command would look something like:

```
cp `pick *` destination
```

and if the directory contains apple, grape, lemon and mango, the pick dialogue would go something like:

```
apple? y
grape?
lemon? y
mango?
```

meaning that pick will print apple and lemon, and only those files will be copied.

Pick extends to all commands the flexibility offered by the -i option to rm. It is a good example of what happens so many times in UNIX:- simple operations combine to make some greater whole - and that's the UNIX philosophy.

**EXE**

*Peter Collinson is a freelance consultant specialising in UNIX. In 1976, as a lecturer at the University of Kent, he was one of the first in the UK to become a UNIX system administrator/C programmer/kernel hacker/guru. He is now involved with consultancy, programming, training and yes... writing. He can be reached electronically as pc@hillside.co.uk (although your mailer might be happier to put the address the other way round) or by phone on 0227 761824.*

*Thanks to Brian Kernighan from AT&T Bell Labs, for permission to use pick in this article. pick is taken from the excellent book The UNIX Programming Environment (by Brian W Kernighan and Rob Pike, published by Prentice Hall, ISBN: 0-13-937699-2). The example shown here is rudimentary, and people intending to use pick seriously are strongly recommended to consult the book.*

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CIRCLE NO. 100

# Books

*There's a distinctly networky feeling to this month's selection of books; with one volume devoted to Novell's Netware and the other to NetBIOS.*

## Effort Rewarded

NetBIOS is an IBM-originated 'standard' for peer to peer communications on PC-based local area networks. It comprises an API that programmers can make use of when they write their programs, and a set of protocols that allow packets of data to be sent and received within a higher level framework. This framework allows the management of complete communications sessions. There are alternatives to NetBIOS, such as Novell's IPX/SPX suite of protocols, but none are as pervasive as NetBIOS, which is available for a multitude of operating systems and networks.

If you need to learn about NetBIOS programming, *The C Programmers' Guide to NetBIOS* is a good place to start, but don't expect it to contain a gentle introduction or an 'executive summary'. The author of this book believes in going into detail, which he does as quickly as he can.

The detailed treatment of the subject matter is admirable and loads of sample source code is provided. The book includes an overview of how to issue NetBIOS commands, code to establish the presence of NetBIOS, explanations of NetBIOS command parameters, and explanations and sample code for all aspects of NetBIOS programming from name support through datagram management to session programming. The book even give sample source code and explanations of how to write a network conferencing application (not quite on the scale of CIX, but it is interesting nonetheless) and how to write device driver redirectors. The last two chapters provide an extremely useful reference guide to NetBIOS. A tear-off card is provided to request the sample code in disk form.

This is a book written by someone who knows his subject inside out. This will not always be true of its readers: the author does not provide a gentle introduction to his subject, and occasionally he goes into unnecessary detail. A considerable amount of space is given to a treatise on CRC programming (maybe Schwaderer's college thesis was about CRCs?). Not enough detail (ok, no detail whatsoever) is given to non-IBM implementations of NetBIOS. To read the book one might be forgiven, at times, for thinking that the IBM PC LAN was the only sort of network.

When I picked up the book the first time, I was expecting to be able to dive in and read it in fragments, extracting information as I required it. This is not possible, and one must read this book end to end for it to be useful (a long session reading it in the bath is to be recommended, from experience). Given the effort, the book pays dividends to its reader. On a recent project with which I have been associated, the *IBM NetBIOS Application Development Guide* (the official IBM reference to NetBIOS) lies hardly used, whereas Schwaderer's book is referred to constantly. If you need to learn about NetBIOS programming, buy this book. *Paul G Smith.*

*Title:* C Programmer's Guide to NetBIOS

*Author:* W David Schwaderer

*Publisher:* Howard W Sams & Company

*Price:* £20.95 ISBN: 0-672-22638-3 *Pages:* 320



## Weighty But Light

*Novell Netware - The Complete Reference* is another offering from the usually excellent Osborne McGraw-Hill stable. You will not, therefore, be surprised to learn that it is 9 inches high, 7.5 inches wide and 2 inches thick with a paperback cover. It also costs four times more than you would expect to pay for any non-computer paperback of similar size. I know that the Computer World is obsessed by standards, but this is no justification for the large number pages required to cover a given subject.

I could not find any reference to the background of the author, Tom Sheldon, other than the information on the back cover. This informs us that he is 'a fully authorised Gold Level Novell service and support technician. He manages the Technical Products Division for a chain of west coast Computerland stores and has worked extensively with network systems, including Novell.' Based on the information packed into the book, Sheldon seems to know his stuff. It could equally be that he is a very good précis writer, who has succeeded in condensing the seven or eight weighty manuals that come with Novell down to a less intimidating single volume. Whatever the truth of the matter, the result is a genuine high-level reference manual for Netware. This enables the user to find the answer to questions without the need to wade through the well-written, but very detailed, red books that come free with Netware.

The book begins with general sections on concepts and components of a network. I found these sections to be fairly weak, as Sheldon seemed both uncertain of what he wanted to say and how to say it. The result is a hotchpotch of views and ideas, that leave the reader with little benefit for making the effort to read them.

The standard of writing improves significantly as Sheldon moves on to cover the world of Netware, the products available and the features provided by each. A section on Novell's connectivity offerings is so good that they would do well to consider using it for their own product summaries.

Sections quickly follow covering planning and installing networks, creating directories, setting up security and day to day operations. This includes a comprehensive look at using all the various facilities and commands that come with Netware. If you want a quick summary that gives you the feel of a command or function, rather than an in-depth explanation, then you will almost certainly find what you're looking for here.

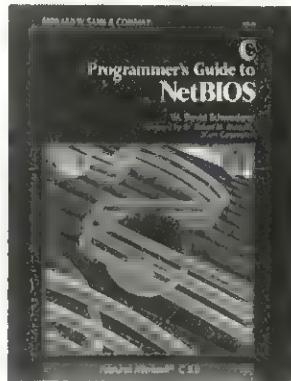
In summary, this is a well-written book that achieves its objective of providing a comprehensive coverage of the Novell range of products. It's not for the 'techie', but if you are new to Novell, or simply want to expand your general knowledge of the products, then 'The Complete Reference' will make a useful addition to the big red collection. It will definitely provide an insight into the sheer breadth of the Novell world. *Dave Apsey.*

*Title:* Novell Netware - The Complete Reference

*Author:* Tom Sheldon

*Publisher:* Osborne McGraw-Hill

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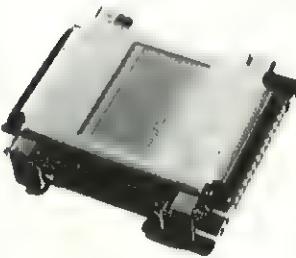
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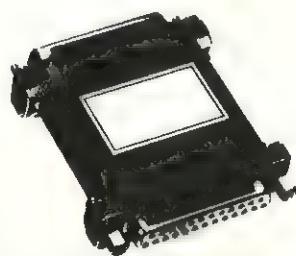
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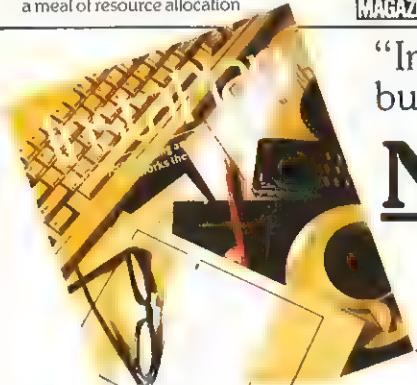
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## DEVELOPERS' MARKET HOLDS FIRM AS INTEREST RATES BITE

The overall rate of recruitment across the IT sector is slowing down for the first time, but technical staff with practical 'hands-on' development skills are expected to enjoy a fairly steady market.

Research by the 60,000 member Computing Services Association shows that there was a drop over the last year in both the growth rate of the industry and the take-up of new staff.

Tony Lewis, Membership Director of the CSA, said that between 1984 and 1988 the annual growth rate in the number of employees was just over 11%. Last year it

rose to 14%, but this year he expects it might drop back to 11% or lower.

Similarly, the growth rate measured in turnover has topped 20% over the last five years, but may fall below that figure in 1990.

Lewis, however, remains optimistic: 'Some people look at the situation and say it's a disaster, but it certainly isn't. 73% of members said business was better than last year: it's still growing, but it's the rate of growth that's slowing. It's a sign of a maturing market.'

David Bevan, Senior Consultant at one of the largest recruitment agencies, Computer

People, said the PC market remained strong and was largely sheltered from fluctuations in the business economy: 'Demand is increasing, and the number of people with PC skills is growing with it, so it remains healthy.' Because supply currently matches demand, salaries are also staying stable.

Bevan added that the areas of greatest current demand include PC technical support, and quality assurance throughout the systems and programming sectors. Firms are also increasingly likely to demand business skills on top of technical training.

## PAYING THE PRICE TO BUILD A GREENER CAREER

Computer staff are choosing to take salary drops of up to £5000 to avoid working for firms with 'unethical' business interests.

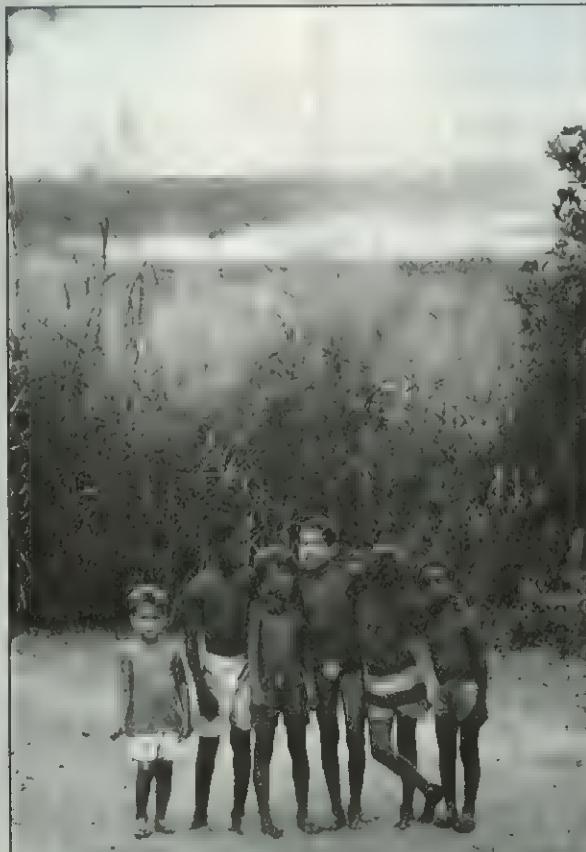
Companies working in the defence or nuclear sectors, or with interests in white South Africa, are being vetted through an ethical recruitment agency, Exchange Resources, based in Bath. Set up four years ago by a former contractor who used to work in nuclear weapons development, the agency attempts to place staff in companies that meet certain principled criteria and which offer equal opportunities.

Some of the largest computer suppliers have appeared on the company's blacklist, although there is some flexibility and, the company admits, some inconsistency. Candidates have been offered positions in particular divisions of offending multinationals if the branch itself passes the test.

Tony Wilson, Founder and Managing Director of Exchange Resources, said: 'We try to encourage individuals to work out what they want from their working lives, and to go for it.'

He added: 'It's amazing how many people we get who are prepared to drop £1000, £2000 or £5000. As people eventually realise that the world is limited and economies can't go on to grow at the rate they are now, they're happy to settle for less.'

This month, Exchange Resources will open two franchises. Wilson, who claims that the managing director of one multinational computer supplier had told the firm 'never to darken their doorstep again', also intends to develop a formal vetting procedure to replace what is currently a fairly ad hoc system. At the moment, the suitability of potential employers is determined from telephone calls, company reports, visits, and contact with groups like the Anti-Apartheid Movement.



Would you lose £5k to stop the Amazon burning?  
SUSAN CUNNINGHAM

## LONG WAIT FOR GUIDANCE IN A HAZARDOUS MARKET

Applicants worried about the quality of training courses will have to wait at least another 18 months before a government-sponsored accreditation scheme becomes operational.

The IT Industry Lead Body, a working group set up by the National Council for Vocational Qualifications, is defining a series of standards, or 'competences', which training organisations will need to prove they can meet. Set up two and a half years ago, the Lead Body does not expect to have developed a comprehensive package before early 1992.

In the meantime, experts warn that IT specialists are in danger of falling prey to the occasional 'cowboy' operator. Rob Roseveare, Careers Division Manager at the National Computing Centre, said the issue of the standard of training was becoming acute. 'People don't perceive training as a level of investment in staff and are likely to take the cheapest solution. The standard outside this country is not all it should be; inside the country, there are more good options around, but there are courses which are oversold.'

He added that potential candidates should look at what criteria are being applied for acceptance on the course - does it include psychometric tests, or is it based on the size of your cheque book? Not surprisingly, he also recommends that candidates look favourably at established course providers.

Barney Gibbons, Chairman of the Lead Body, said the working party had been 'sweating away' for two and a half years. It should have completed 80% of the competences by the end of this year, although the remaining 20% would be the toughest to define. As a stopgap, the NCVQ intends to offer conditional accreditation to individual courses for two years.

*Keith Rogers.*

# CAREER DEVELOPERS

## SOFTWARE MANAGER

### SURREY

to £25k + CAR  
My client, a small but well-established & expanding Systems Design Consultancy with excellent reputation in the International Aerospace Industry seeks Senior Software Engineer to head up new Software Dept.

Ideally in your mid-late 20's, with varied low & high level languages plus experience of Structured Techniques (eg, ADA, JSP etc) & the ability to present solutions to Junior Engineers & Co. Directors alike. Tremendous career opportunity affording continual technical variety, UK & International travel - and the chance of playing a key role in shaping the Company's Software Development strategy.

**C + ADA = £££'S!**

to £25k pa

### GUILDFORD

Very prestige Software Engineering Consultancy, providing specialist Development Services to the UK Aerospace, Energy & Control Systems Industries NOW recruiting Software Engineer at Project Manager & Consultant levels.

Ideally you will have good Hons degree in Comp. Science or Maths + 3 years "hands-on" in Real Time Digital Systems to include 2 Assemblers, & 'C' in an ADA (or similar) structured environment. Very Professional Company, excellent working environment, committed & enthusiastic Management Team - superb career opportunity for the forward looking young Professional.

Contact David Bird on

081-549 6441.

59 Eden Street, Kingston, Surrey KT1 1BW.  
Tel: 081-549 6441. Fax: 081-549 6462.

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IBM P.C.'s, MS-DOS, BIOS, 8086/80286 Assemblers and 'C'. Graphics involvement and H/W Interfacing.

**SOFTWARE ENGINEERS HOME COUNTIES 11K TO 18K**  
ISDN development. Experience of Comms based Data Interfaces using 'C' UNIX/PASCAL.

**SOFTWARE ENGINEERS HERTS c20K**  
Development of Integrated Office Systems. Experience in the I.T. Industry, using 'C' UNIX/DOS.

**SOFTWARE Q.A. MANAGER HANTS TO 25K**  
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**SENIOR SOFTWARE ENGINEERS HOME COUNTIES TO c18K**  
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# The Azure Project (15K to 25K)

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- **Database Specialist** Creating the database storage & access routines providing fast, low level routines to enable easy, high speed use of the system.

- **Printer Specialist** Producing routines to take complex documents created by the main database software and/or WordPerfect and printing them to DeskTop publishing standards.

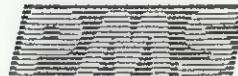
- **Presentation/Graphics Specialist** expert in all areas ranging from scanner input to creation of graphics and on to a Graphical User Interface.

- **Language Specialist** Formal understanding of computer languages will be essential to work on two language projects: the automatic conversion of C source between OS/2, UNIX and DOS and the compilation of The Azure Project's database language.

We are looking for individualist in a team which will be based in **Sleaford** in Lincolnshire; for programmers who love computing and who want the opportunity to create a world class product in a progressive and expanding company; rewards for the successful applicants will be substantial with initial salaries starting at £15,000 to £25,000 depending on experience and background. Write (not phone) with a full CV to Barbara Westrup at our Sleaford office for more details of this exciting opportunity.

**ESTATE COMPUTER SYSTEMS LTD**  
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Please reply to Sleaford

OVER SIXTY YEARS OF PROPERTY EXPERIENCE



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## MS-DOS Programmers

We are a rapidly expanding software house, specialising in developing and marketing of communications and office automation products for major UK organisations, including British Telecom.

We're looking for an energetic programmer to join our committed and professional team to work on a major new exciting project.

Interested? The skills you'll need to apply are:

- software design
- minimum of 2 years 'C' programming
- developing applications to run under MS-DOS
- a good communicator.

It would also be an asset if you've been involved with TSR and device driver programming, software engineering of comms or office automation products and are familiar with 8086 Assembler.

The rewards? We're offering an attractive package including a salary of up to 20K, a company bonus scheme, BUPA and a strong commitment to advanced training.

If you think you're the person we are looking for write to:

The Technical Director  
The PMS Group  
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Birmingham B5 4LJ

DIP Ltd has designed, developed and produced THE IBM-compatible POCKET PC, sold as PORTFOLIO. They are currently writing an enhanced PC compatible BIOS for palmtop computers. Development will be exciting and fast-paced, pushing the IBM PC architecture to its limits.

**SOFTWARE ENGINEER,  
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## IBM PC BIOS + DEVICE DRIVERS at DIP

Ref: 132569/jh

If you are enthusiastic, know 8086 assembler, DOS and are interested in a career with this young vibrant company, please contact their consultant Julianne Hull.

### TECHNICAL PERSONNEL

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GUILDFORD  
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Telephone: 0483 65566  
(24 hours)



## SKILLED IN UNIX and 'C'??? MOVE INTO SUPERCOMPUTING!!

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**UNIX-based Software developers, To £24000 plus Car!**  
**West London.** Working in 'C' at system level to port DBMS, Graphics, Risk Management and Decision Support software onto massively parallel architecture!!

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Expand your skills in UNIX by providing a technical bridge between development and suppliers! Training offered in transputers, Occam, OOP and Windows!

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COMMUNICATIONS  
4GLS-RELATIONAL DATABASES

Excellent communication and presentation skills are essential. In return for your expertise you will be joining an elite team of UNIX professionals in a company that has been growing at 70% p.a. for the past 2 years.

Please ring our selection consultant JERRY HERD for an informal discussion on 081-504 2204 (office). Or alternatively send a detailed CV (including salary and preferred locations) to Michael Bailey Associates (Recruitment Consultants), Rococo House, 281 City Road, London EC1V 1LA.

**MBA**

Michael Bailey  
Associates  
Recruitment Consultants

**MBA**

## THE UNIX RECRUITMENT SHOP



**MANAGEMENT CONSULTANTS, Central London (£25k - £Neg)**  

- 8+ years Development & Management experience
- Experience of OSI Architecture
- Understanding of emerging Open Systems Technologies
- Effective communications with people at all levels
- Understand the latest concepts in Quality and the use of modern design tools

**SENIOR SOFTWARE ENGINEER, Portsmouth (£20k - £Neg)**  
 Commercial experience a must.  
 Good interpersonal, presentation & project planning skills.  
 Experience Informix 4gl essential.  
 Experience of Datacom, Office Automation | Networking



**EIS/MIS SUPPORT/CONSULTANT, Berks (£20k - £Neg)**  

- Excellent Communication Skills
- Technical background in IBM, DEC or Unix Environment
- High analytical and problem solving abilities
- Willingness to travel overseas.



**PROGRAMMERS, Middlesex (£11k - £16k)**  
 3+ years programming experience in C.  
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 Experience of EPOS



Open Systems People Ltd is a technical recruitment agency specifically aimed at recruitment of staff at Technical Support, Systems Programmer, Project Leader and Middle Management levels. Our clients are involved in 'State-of-the-art' software engineering, in fields such as Electronic message handling, Document architectures, Relational Databases, LAN/WAN, Graphical User Interfaces, and other emerging technologies. If you have a strong background in Unix then make a move in the right direction and contact Open Systems People, your technical friends in recruitment.



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0767 315795 - Fax  
for an informal discussion.  
Alternatively fax or write



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# SOFTWARE DEVELOPERS

## SURREY

Versatile 'C' programmers to develop real-time, interactive, image processing and graphics systems. Any of the following useful: **UNIX, OS9, Object-oriented Design, IBM PC or Macintosh experience**

## CAMBS

Developing Database Management Systems and Program Generators, you should have 'C' experience either under MS-DOS, UNIX, VMS or FlexOS. MS Windows, Presentation Manager or X-Windows knowledge very useful.

## E.MIDLANDS

Leading supplier of **UNIX** based business systems is seeking 'C' programmers and **Informix 4GL** programmers with a minimum of one years experience. Training provided in **Youndon** and **CASE** tools.

## W.MIDLANDS

Rapidly expanding established Communications software house seeking minimum 2 years experience of 'C'/MS-DOS in a commercial or industrial environment. Any of **80x86 Assembler, TSR or Device driver** experience useful.

## HANTS

Microprocessor Software developer sought by international communications company. You should have 'C' and **Assembler**, hopefully with experience of either **MS-DOS, UNIX, ICE or Structured Design Methods**.

## LONDON

Designing Personnel Systems for the international marketplace, our client is keen to recruit 'C' programmers under **MS-DOS**. Any **Networking, 8086 Assembler, or Database Design** experience useful.

## LONDON/MIDDX

International company seeks Software Engineer with M68000 **Assembler** experience to develop Real-time comms. 2 to 5 years' experience.

**to £20k**

**£15k - £21k**

**to c£16k**

**£15k - £20k**

**c£18k**

**£15k - £22k**

**c£22k+car**

**£16k - £23k**

**to £17k**

**to £17k**

**£18k - £21k**

**£15k - £30k**

**to £17k**

## HERTS

Electronic Publishing specialist keen to recruit 'C' Software engineers with experience in a real-time, hopefully structured environment. At least one of the following would be an added advantage: **PC's, C++, OOP, UNIX, TCP/IP, NFS, OSI or Postscript**.

## ESSEX

Small team, developing **LAN/WAN Communications** interest you? Then you should have good **UNIX/C** skills - any of the following would be an added bonus: **x.25, TCP/IP, ISO 7, Windows, Networking or UNIX Operating Systems** experience.

## AVON

Developing **EDI Comms, Insurance and Financial Systems**, you should be an analyst/programmer with good **UNIX** experience with either 'C' or **FORTRAN**.

## ITALY

Remote Sensing project requires good **FORTRAN** skills on **VAX/VMS** - any 'C', **Interactive Graphics, PV-WAVE** or signal processing experience useful.

## BEDS/BUCKS

Leading consultancy developing modelling software systems is seeking graduates with sound **FORTRAN** skills combined with one or more of the following: **UNIX/ C, X-Windows, Graphics, Database or Q.A.** Support roles also available.

## HERTS

Developing applications software for the **Secure Systems, Retail, Process Control, Insurance and Health Care** market, is seeking 'C'/**UNIX** skills with hopefully **SQL, Oracle or Methods** experience, although training will be provided.

## MANY MORE INTERESTING POSITIONS THROUGHOUT THE U.K!

Contact us to find out more about these posts or the many others that we have. As specialists in the industry, we can provide you with a professional and confidential service in assisting you with the right career move. Telephone or write to one of our consultants.

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Prestigious corporation requires high level consultants with an all round knowledge of the PC market and specialist expertise in either XWindows, Databases, or networking/communications to administer consultancy to senior I.T. professionals.

### PC ANALYST PROGRAMMER

'C'

**£17500 + BENS + MORTGAGE SUB**

Financial institution have vacancy for ambitious individual with minimum 12 months' experience as PC analyst/programmer. Experience of Turbo or Microsoft 'C'. Knowledge of Networks useful.

### NETWORKING SUPPORT

**£18k + Car**

Major distributor requires systems engineers with experience of Novell P.C., LAN or Torus.

### TECHNICAL SOFTWARE SUPPORT

**£10k + Car**

Micro Computer manufacturer require P.C. support specialists with 6 months' experience. Probably from an End-User dealership background you will have a knowledge of a variety of 'off the shelf' packages e.g. dBase, Lotus, Multimate, Pegasus, Smal, etc. to provide support to dealers, distributors and VAR's.

### FINANCIAL INSTITUTION

**AS400/R1 Professionals**

Environment: IBM AS/400/RPG

Relational Database design

Full PC - Networking and AS/400 connectivity

Objective: Complete support of the money market trading settlement operations, dealer-trader decisions support and interface to corporate accounting systems.

### D-BASE/CLIPPER OR FOXBASE ANALYST PROGRAMMER

**£18k + BANKING BENS.**

Stockbroker has opening for experienced database programmer analyst to develop financial applications for their busy dealing room area very exciting work environment.

### UNIX SPECIALIST - SUPPORT AND DEVELOPMENT ALL LEVELS -

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Full listing of vacancies available.

Call 071-323-6880 and ask for full details of vacancies.

FOR FURTHER DETAILS ON OPPORTUNITIES IN

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LWT/Thames areas and  
page 287 elsewhere

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# Technical Software Vacancies

## WINDOWS/OS2/ PRESENTATION MANAGER

**London/Thames Valley £18-28K**  
A joint venture company between a world leading Information Technology centre and various financial institutions is aiming to increase its workforce by a massive 30%. In order to be part of this exciting development you will be degree qualified, have 2 years experience in structured software design and ideally be versed in communications protocol and interface design. In return for your knowledge of the 'C' language, together with MS WINDOWS or PRESENTATION MANAGER you will be actively involved across the entire software life cycle and be offered an attractive salary, bonus scheme, family medical plan, pension scheme and free foreign language tuition! Ref: MJ25100

## RECENT GRADUATES M.Sc GRADUATES

**Various Locations to £15K**  
We have a large number of clients ranging from a major international defence contractors through to small, independent software houses who have an urgent requirement for technically qualified graduates with software experience. If you can offer C/UNIX, ADA, PASCAL, COBOL or any Real Time experience we can offer you a number of interesting opportunities. MJ2557

## C → C++

**N.H. Counties to £30K**  
Would you like to develop your expertise in Graphics, Database, Data Comms, Object Orientated Design, Expert Systems or Distributed Processing? Would you welcome the opportunity to TRAIN in C++? If so, and you can offer a good technical degree and a minimum of 1 years experience in C/UNIX you could be working on a variety of technically challenging projects within a small, rapidly growing Systems House. Along with this golden training opportunity my client offers private medical care, company pension, bonus scheme and employee share options. MJ2563

## NETWORKING/COMMS SOFTWARE

**London/H. Counties to £30K + Car SKILLS**

\* C/UNIX \* VAX/VMS \* X25 \* X400  
\* PC-DOS \* IBM \* OSI \* SNA

### OPPORTUNITIES

Consultancy, Finance/Retail/Comms, Design/Development, Commerce/Government

### BENEFITS

Excellent Salaries, Company Pension, BUPA, private and medical insurance, generous relocation package, varied, interesting projects and superb career development. MJ2570

## SECURE COMPUTING

**Hampshire to £30K + Car**  
Our client, a joint venture company between one of the UK's leading technical consultancies and the UK's foremost communications company is actively seeking experienced software engineers to lead the way in Secure Computing Systems. With good, sound experience in C/UNIX, 68000 ASSEMBLER, 4GL/SQL, FORMAL METHODS or OPERATING SYSTEMS you can expect to break new ground in the Planning, Design, Implementation and Evaluation of Total Security Systems for the Government, Industry and Commerce sectors. Technically challenging, stimulating work in an advanced technology environment in the industries most exciting growth potential field. A generous salary, relocation, company pension, private medical insurance and BUPA complete the benefits package. MJ2565

For more details on these opportunities call MIKE JENKINS on 0442 231691 office hours or 0582 456417 eves/wkends. Alternatively mail CV to Executive Recruitment Services, Hempstead House, Selden Hill, Hemel Hempstead, Herts, HP2 4LT or fax on 0442 230063

ERS

## STOB - Letter from Parity

*Like Sherlock Holmes himself, Verity is cursed with a smarter, elder sibling.*

*Parity Stob is also a computer programmer. She works for WED (Weinstick Electric Death) Ltd, and sometimes corresponds with her baby sister.*

Darling Verity,  
My transfer finally came through last week, so am now working on the SMPTJFALHW-FIAH project (Secret Military Project Teach Johnny Foreigner A Lesson He Won't Forget In A Hurry). Had the option of joining Anti-Personnel Missile Control (office near to the coffee machine, nice new ergonomic terminals, but Team Leader has BO problem) or Devastation Maximisation Unit (office has window with interesting view of main road, and Team Leader has hilarious red-haired toupee). Plumped for Ginger's outfit, as in the event of personal side-by-side supervision at terminal, his company more salubrious.

Can't say which country this stuff is for - Official Secrets, and all that - but, to give you a clue-ette, the Operational Requirement states that our hardware must be capable of being shipped disguised as consignment of amusement arcade machines. The DMU CPU module that we are working on is going to be got up as a Fruity. One of the last jobs, before it goes out, is to get it to flash the message WANT A GOOD

TIME? COME AND PLAY ME! JACK-POTS GALORE! on its status lights, in case of a snap inspection at Customs.

Of course, we wouldn't have to clown about like this if it wasn't for the Cold War thaw. Morale is very low. Each fresh piece of good international news brings a wave of despondency. The dragon i/c stationery (you know, the one that wears a face that she should leave in a jar by the door) didn't understand why the VAX laser printer was consuming two toner cartridges a month, so she had the operator list the print queue. There were 27 files pending, all from different accounts, all called 'CV.DOC'.

Another source of gloom is the usual antagonism between permies and subbies. Bostock, Head of Secondary Comms, is a particularly self-satisfied son of Thatcher era. He is quite handsome in a middle-aged, smoothie sort of way (if you don't mind grease with your chips), always wears Old School cuff-links and a smirk, and is given to cornering permies and explaining why we are such fools. I went into his office the

other day, to borrow the Secondary Comms Data Dictionary, and received fully ten minutes of this spiel. He ended by saying: 'No Parity, if you want to make any progress in this life, you've got to keep your hand up to the skirt of Fate.' I thanked him for this pearl of wisdom and left pronto for Ladies to wash my hands. Resolved to wear jeans to work henceforth: don't want to suffer Fate's fate.

Bostock is right about career prospects, though. Just look at the company cars. Ginger has been here seven years, loyal idiot, and all he has to show for it is a Ford Yobbo. Head of project only manages a Vauxhall Salesrep, and the flashiest car on site is the Chief Security Guard's Ford Fatman. Which reminds me: must go, need to pick up new id pass. Lost original four days ago, since which time have been presenting bus pass to get in. If the gate guard ever took off his mirrored shades, Parity would be dead meat.

Take care, love + kisses  
PARITY

# Opportunities for Software Professionals

## SYSTEMS/CASE

### ★ FIELD APPLICATIONS ENGINEER BERKSHIRE £20k + Car

To provide pre + post sales consultancy + support for CASE tools in a real time embedded systems environment, responsible technical role. Exp. req. in ADA and C plus realtime kernels eg PSOS, VRTX, VERSAdos etc.

Ref/PRF

### ★ SYSTEMS ANALYST

### BERKSHIRE TO £20K + European Travel

At least seven years analysis and COBOL programming experience required to help design and build a new European Integrated package for this International company. Honeywell DPS8 and DM4/TP are advantageous as is the ability to speak any European Language.

Ref/1670/05

## REALTIME

### ★ SYSTEMS PROGRAMMER

### BERKSHIRE TO £17K

Create new Run Time Systems using 8086 / 80286/80386 assembler and provide maintenance support to all OEM customers. Additional experience of three of the following is essential:- DOS, OS/2, COBOL, C, FLEX, UNIX or VM.

Ref/1630/05

## REALTIME

### ★ SENIOR PROGRAMMER

### SURREY TO £16K

Must be able to write small program specifications, have a logical approach to problem solving and have around three years experience in areas such as configuration control, CASE Tool support, coding and Testing ADA or PASCAL/ CORAL 66 and VMS experience is necessary.

Ref/1504/01

### ★ SOFTWARE ENGINEERS

### HAMPSHIRE TO £24K

To design & develop radio trunking systems + special customer projects involving the analysis of requirements, upfront task design, writing software, test & integration and system testing, educated to degree standard plus R/T experience using VAX/VMS.

Ref/ 1460/00

## UNIX ★ UNIX ★ UNIX

### ★ MATHEMATICAL MODELLING and SIMULATION TO £25K

Good GRADUATE in Maths/Physics/OR Computing for Complex Systems Design and Analysis or Discrete Event Simulation. Experience of FORTRAN.

Ref/ D/388

## UNIX

### ★ C PROGRAMMERS

### NATIONWIDE TO £22K

We continue to experience a massive shortfall in experienced C Programmers and can offer a variety of interesting and challenging positions. If you can develop, implement and test quality Software in C, under either UNIX or MS-DOS then we can probably find you the job you want.

Ref/1669/

## CONSULTANCY/SUPPORT

### ★ POST SALES SUPPORT

### BERKSHIRE £15-20K+

Knowledge of manufacturing industry, in particular production control & inventory management. Software experience of RPG111, IBM AS400, IBM 36/38. Duties will include bug fixing, application development and implementation. Travel possible.

Ref/1381/05

## CONSULTANT

### ★ SURREY £15-20K

At least 10 years experience with a thorough computer science background. Should possess experience of small project management with real time skills using ADA, PASCAL, CORAL 66 or VMS

Ref/1501/01

## CONSULTANCY/SUPPORT

### ★ NETWORK APPLICATIONS SUPPORT

### BERKSHIRE TO 23K + CAR

This position involves installation of PC Networking applications and its support, network security and database maintenance. Experience of NOVELL NETWARE, LOTUS, EXCEL and wordPERFECT is required along with some exposure to PROGRESS 4GL

Ref/ 1671/05

## MANAGERIAL

### ★ SOFTWARE ENGINEERING TOOLS MANAGER

HAMPSHIRE c£23K + CAR

Minimum 10 years experience (preferably software house background). Extensive knowledge & use of software engineering tools - automate, excelerator, software through pictures, information engineering workbench, Yourdon workbench.

Ref/1433/00

## MIS/DATABASE SYSTEMS

### ★ TECHNICAL CONSULTANTS

### LONDON TO £14-20K

Experience of applications design and development using informix or ORACLE. Cross training can be provided with experience of other open systems rdbms. This will be an analyst/programmer role involving systems design and programming, client contact and the use of SSADM. Jackson and Yourdon.

Ref/ 1005/12

## OFFICE AUTOMATION

### ★ ANALYST PROGRAMMER

### NORTHAMPTONSHIRE £10-14K

To support existing applications for supplied & bespoke software, analyse business requirements, including the development of bespoke systems, installation of new hardware & software. Knowledge of LANs, spreadsheets, dBase IV useful.

Ref/1494/55

## GRAPHICS/CAD/DSP

### ★ CAD DEVELOPMENT ENGINEERS

### BERKSHIRE £15-19K

High level language programmers from a CAD/CAE or similar background needed to develop suites of CAD tools for ASIC/VLSI state of the art environment. UNIX, C, PASCAL, LISP. Knowledge of industry standard tools an advantage.

### ★ DSP ENGINEERS

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Rapidly expanding systems house applying DSP expertise to high tech industries eg satellite communications. Knowledge of DSP software or hardware essential. Excellent salaries and working environment.

Ref/ D/BOB

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ANITA HARVEY ON (0734) 774234 or (0734) 794278 after 7p.m.

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Natural selection provides unique passive protection for the porcupine.

# The Activator - Natural Selection For Software Protection



Inventor and entrepreneur  
Dick Erett explains how  
"The Activator" provides  
sane protection for your  
intellectual property.

"In any industry, just as in nature, the process of natural selection raises one solution above another. Natural selection is the most elegant of engineers.

In the area of software protection The Block has been selected by the marketplace as the solution that works. Over 500,000 packages are protected by our device.

For the past 4 years our philosophy has been; 'You have the right and obligation to protect your intellectual property.'

## A New Ethic For Software Protection

In allowing end-users unlimited copies of a software package and uninhibited hard disk and LAN operation, The Block has created a new ethic for software protection.



"On-the-fly" programmable memory option now available for OS/2, MS-DOS and Macintosh

By removing protection from the magnetic media we remove the constraints that have plagued legitimate users.

They simply attach our key to the parallel port and forget it. It is totally transparent, but the software will not run without it.

## A New Technology For Software Protection

Our newest model, The Activator, builds on our current patented design, and establishes an unprecedented class of software protection.

We have migrated and enhanced the circuitry of The Block to an ASIC (Application-Specific Integrated Circuit) imbedded in The Activator.

This greatly improves speed and performance, while reducing overall size. Data protection can also be provided.

## Programmable Option

The Activator allows the software developer the option to program serial numbers, versions, or other pertinent data known only to the developer, into the circuit, and access it from the program.

Once you program your part of the chip, even we have no way to access your information.

The ASIC makes emulation of the device

virtually impossible. It also presents an astronomical number of access combinations.

## Full 100% Disclosure

Since The Activator is protected by our patent we fully disclose how it works. Once you understand it, endless methods of protection become evident.

Just as no two snowflakes are the same, no two implementations of The Activator are identical. And like the snowflake the simplicity of The Activator is its greatest beauty.



"We never cramp your programming style...  
genuity. Make it as simple or complicated as you desire."

Let us help safeguard what's rightfully yours. Please call today for additional information or a demo unit. It's only natural to protect your software."



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